

April 2015

Science Reporter



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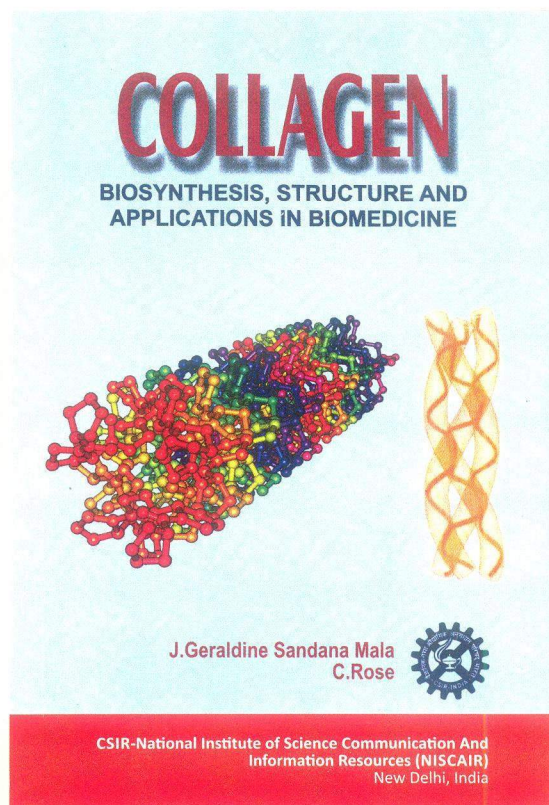


COLLAGEN

BIOSYNTHESIS STRUCTURE AND APPLICATIONS IN BIOMEDICINE

The book comprises of 7 chapters which provide up-to-date information on collagen Science, including, elucidation of biosynthetic pathways and structure-function relationship and applications in tissue regeneration, wound healing and drug delivery. The book is designed for graduate study as well as for young researchers and experienced scientists. The basic aim is to provide technical information to leather technologists, both in academics and in industry. A special section on the chaperoning functions of heat shock protein 47 is included while such information is rarely provided in other books of interest. Several results from the author's research work which have been published in peer-reviewed journals are presented.

The book is aimed to enrich the understanding of leather chemists with biological information and update their knowledge in collagen research. Overall, the book is a handy reference for those in the field of leather technology and in basic collagen research and is also suitable for beginners interested in collagen science.



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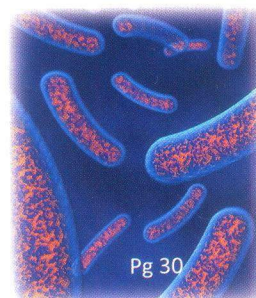
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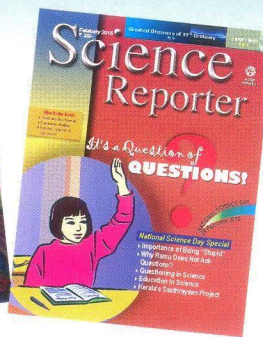
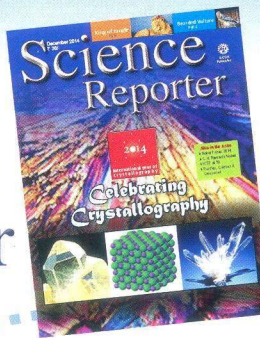
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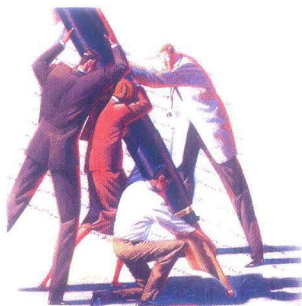
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Science Reporter



INFINITE IGNORANCE

In the cover story **The Importance of Being Stupid** (SR, February 2015), T.V. Venkateswaran has mentioned that what we don't know is not merely vast, but for all practical purposes, infinite. Perhaps in A somewhat similar vein about



2000 years ago the Tamil poet Avayyar said, "Knowledge acquired is that of one's palm's size, unlearned is as huge as the world". The poet Zauq said, "Jaana To Ye Jaana Ki Kuch Bhi Nahi Jaana".

The author goes on to say, "Since our ignorance is infinite, the only way forward is to muddle through..." Alexander Pope advocated hard labour:

A little knowledge is a dangerous thing;

Drink deep, or taste not the Pierian spring;

There shallow draughts intoxicate the brain;

And largely drinking sobers us again.

Dr. S.K. Gurtu, Jaipur

STUPID OR IGNORANT?

The article **The Importance of being Stupid** in the February 2015 issue was an informative compilation of some ten unsolved questions in science in search of answers although



not all the problems cited remain unsolved. For example, embryogenesis – the process of cell division and cellular differentiation of the embryo that occurs during the early stages of development of foetus is now fairly well-understood. The author's analogy of a brick lying on an open ground becoming a skyscraper by itself with the formation of a human baby from a single fertilised cell is too far-fetched. There is no similarity between the two because the latter one is precisely orchestrated by a multitude of chemical and biochemical processes that drives the living process whereas the former is not.

I found the title of the article rather jarring. The meaning of 'stupid' according to the Oxford English Dictionary is 'lacking intelligence or common sense'. Can a person lacking intelligence and common sense ask intelligent questions and find answers? Ignorant would have been more apt.

Biman Basu, Delhi

The author replies:

While I agree with Mr Biman Basu the question of embryogenesis is not in the same league as say dark matter in so far as our knowledge is concerned, it is an exciting field where research is on going to fill the gaps.

Sometimes when one uses an analogy it is to give an exaggerated caricature of a certain aspect. The article I have cited, Importance of Being Stupid, makes a point that while in school and college doing well in courses means getting the right answers in tests. If you know those answers, you do well and get to feel smart, but for research one needs to have a disposition of 'productive stupidity'.

T.V. Venkateswaran

LEARNING FROM QUESTIONING

I have been a regular reader of *Science Reporter* since my 11th class, now I am a graduate student. I have found the magazine very helpful. I always learn something new from the magazine.

The feature article of February 2015, **Questioning in Science** by Dr. Monika Koul is a great article. We all know that when we ask questions, we learn something new. And in science asking is very important. Thank you for publishing such articles. Sourav Chakraborty Kolkata

RAMU'S QUESTIONS

This edition of *Science Reporter* (February 2015) made me think once again what I am and forced me to change my opinion about questions. I was also 'Ramu' but after reading the article Why Ramu does not ask Questions by Mr. K.P. Madhu I could change myself and would like to thank the author. We must all ask questions.

I liked the article Mr. Rakesh Mohan Hallen, Education in Science, because it tells the truth about our education system that the focus is on qualification not on knowledge and that is why people like the great mathematician Ramanujan suffer due to this education system. It must change. Shivendra Pratap Singh Kota, Rajasthan

INDIAN CONTRIBUTION

This is with reference to the article **The Golden Mathematics of Life** in the January 2015 issue. For a student, it is a very informative article. But I was surprised to find that the amazing Indian contribution to the same mathematical area goes unmentioned. The so-called "Fibonacci series" (including the concept of the Golden Ratio, surprisingly!) finds first mention in the works of Indian Mathematicians like Hemachandra, Gopala, Pingala, etc. as it is historically accepted today. Even Manjul Bhargava has spoken about it calling it the "Hemachandra Series".

Sree Charan

csree79@yahoo.com

EINSTEIN'S REFRIGERATOR

The short feature article written by Dhrubajyoti Chattopadhyay, **Einstein's Refrigerator** (SR, January 2015), is extremely interesting and new to most of the readers. The main advantage of this refrigerator is the reduction of moving parts in its construction. We know Einstein the theoretical physicist with an excellent mathematical brain has designed this type of refrigerator. Thanks to Science Reporter for publishing such articles.

Sandip Sinha

sandip11tech@gmail.com]

HAVE YOUR SAY

Please write to us at the postal address given in the magazine or send an Email at sr@niscar.res.in.



Science Reporter

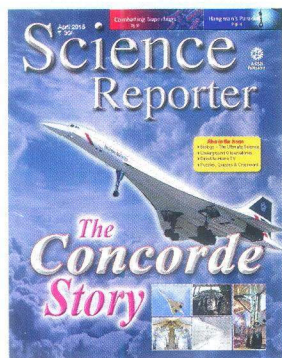
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COVER DESIGN
NEERU SHARMA

NATIONAL SCIENCE WEEK?

We celebrate the National Science Day every year on February 28. The Government of India designated this day as the National Science Day in 1987 to honour the Nobel Prize winning discovery of the "Raman Effect". Sir Chandrasekhar Venkata Raman, the eminent physicist, working in the laboratory of the Indian Association for the Cultivation of Science, Kolkata announced the discovery on this day in 1928. Two years after this discovery, in 1930, C.V. Raman brought the first Nobel Prize for the country.

The basic objective behind designation of a specific day in the year as the National Science Day was to spread scientific awareness among the people, inculcate in the country's citizens a scientific spirit and a scientific attitude. The day is also an opportunity for scientists, technologists, policymakers and political leaders to not only celebrate the success of Indian science, but also to take stock of the progress made by the country in different areas of science and technology and chart the path ahead with more commitment and enthusiasm to achieve higher realms in S&T pursuits.

The first National Science Day was celebrated on 28 February 1987. Twenty-eight years later, perhaps, it is time to take a fresh look at the National Science Day. How have the programmes to celebrate the National Science Day impacted the masses? Has participation in these celebrations throughout the country increased or decreased? Which are the areas that still stay untouched or unaccessed? How creative are the programmes being organized as part of the National Science Day?

It might also be opportune to look at graduating from a National Science Day to a National Science Week. Rather than the celebrations fizzling out in a day, perhaps there could be more widespread celebration of science spread over a week's time at the national level, moving down to the state and the district level.

The programmes can also be coordinated by way of setting up a dedicated website that could list various events being organized and which could be consulted by people to access the event they would be interested in or the celebrating organization nearer to where they stay. The site could also be devoted to seeking and giving ideas for creative programmes that could be organized to ensure widespread participation.

By motivating organizers to register their events on the website a fairly comprehensive account of activities conducted throughout the country can be recorded and analysed. Further, blogs associated with the parent website could give out event reports and case studies for further evaluation and strengthening of future programmes.

Hasan Jawaid Khan

Printed and published by Deeksha Bist on behalf of the National Institute of Science Communication And Information Resources (NISCAIR), CSIR, Dr K S Krishnan Marg, New Delhi-110 012 and printed at Thomson Press (India) Ltd., Faridabad.

Science Reporter is published monthly by the National Institute of Science Communication And Information Resources (NISCAIR), CSIR, Dr K S Krishnan Marg, New Delhi-110 012. NISCAIR assumes no responsibility for statements and opinions advanced by the authors or for any claims made in the advertisements published in *Science Reporter*.

For Editorial Queries: Ph.: 91-011-25848702; Email: sr@niscair.res.in; Fax: 91-011-25847062

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DOES ILLNESS MAKE PEOPLE LONELY?



DIFFICULT circumstances often bring people closer together. But a new Concordia University study published in *Health Psychology* has found that the onset of chronic illness often results in sufferers feeling lonelier — even for those who have had a steady partner for 50 years or more.

Researchers at the Personality, Aging, and Health Lab at Concordia University took on the study because they found that, while plenty of research examined the effect of loneliness on illness, there was a lack of empirical evidence about whether or not illness contributes to loneliness.

"We were surprised by the amount of literature that examined whether people who are lonely are more likely to get sick," says Meaghan Barlow, the study's first author. "Yet none of them asked the opposite question: 'Do sick people get lonely?'"

The new study reveals that they often do when they advance in age, and that it happens regardless of being in a long-term relationship when faced with a bleak diagnosis. "The quality of our social ties plays a role when it comes to coping with the effects of serious disease in later life. And just having a partner around may not be enough," Barlow says.

Barlow and her co-author, Sarah Liu, measured changes in loneliness between 2004 and 2012 in a sample of 121 older adults who were mostly in their 70s. The study was supervised by Carsten Wrosch, who holds a research chair in aging and health at Concordia.

Looking at the numbers provided some insights into how self-protective strategies can reduce the stress associated with a serious health issue. In particular, positively reappraising a difficult health situation and not blaming oneself for the illness prevented feelings of loneliness, most likely because it helps maintain motivation for social involvement and prevents depressive symptoms. "Putting a halt to socializing only contributes to a downward spiral," Barlow says. "Dealing with a chronic illness shouldn't prevent you from still trying to get out there if you can."

Naturally, the challenge for society is to help an aging population find motivation to stay engaged, which means recognizing that the psychological side effects of disease can be offset with an increase in inspiring activity.

"The fact that loneliness can lead to further complications means that measures can be taken to prevent the effects from looping back around," Barlow says. "Finding different ways to connect with other people also means you are less likely to blame yourself for being sick, and you can't count on a partner to fill that gap."

TRANQUEBAR — RESEARCH CRADLE OF INDIAN BIODIVERSITY

TRANQUEBAR or Tharangamapadi, situated in the Nagapattinam district in Tamil Nadu, holds the pride of place as the first modern scientific study of Indian flora and fauna was conducted here.

Johann Gerhard Koenig a student disciple of Carl Von Linnaeus arrived at Tranquebar in 1768 as a physician. Members of the Danish and Moravian missionary formed the Society of the United Brothers ("Societas Unitatis Fratrum") with the primary objective of studying the natural history of the place.

Initially Koenig worked on the termites of Thanjavur and published *Termites of Thanjavur District* in 1779,

the first scientific publication of an Indian insect. Subsequently, he aimed to compile the natural history of India after the publication of Linnaeus' *Instructio Peregrinatoris*. It is reported that Koenig sent plant and animal specimens from Tranquebar to Linnaeus and also to his fellow colleagues Johan Christian Fabricius, Solander and Thunberg who were also student disciples of Linnaeus working on natural history elsewhere.

Linnaeus impressed with Koenig wrote to a friend, John Ellis, "Koenig had found a lot of new things in Tranquebar." As a gesture of his appreciation Linnaeus named the curry leaf plant as "*Murraya*

koenigii", while Fabricius named a bug as "*Dysdercus koenigii*".

There were others to join the bandwagon of naturalists in the Societas Unitatis Fratrum at Tranquebar i.e., Anderson, William Roxburgh, Benjamin Heyne, Klein etc. Roxburgh often referred to as "Indian Linnaeus" published his *Plants of Coromandel Coast* in three volumes in 1795, 1802 and 1812. Subsequently, he also published *Hortus Bengalensis* and *Flora Indica*.

The British, later, took over the scientific study of Indian flora and fauna with the series of *Flora and Fauna* volumes of British India which still are the standard

UMAMI COULD BE BENEFICIAL FOR HEALTH

THE umami taste could have an important and beneficial role in health, according to research published in the open access journal *Flavour*. The journal's special series of articles 'The Science of Taste' also finds that 'kokumi' substances, which modify flavour, could improve the taste of low-fat foods.

Guest editor Ole Mouritsen, professor of biophysics at the University of Southern Denmark, said: "In general, our understanding of taste is inferior to our knowledge of the other human senses. An understanding and description of our sensory perception of food requires input from many different scientific disciplines."

Despite the widely held belief that monosodium glutamate (MSG) is an unhealthy addition to food, researchers from Tohoku University Graduate School of Dentistry, Japan, show that the taste it triggers, umami, is important for health, especially in elderly people.

In a small study of 44 elderly patients, the researchers showed that some elderly patients suffer a loss of the umami taste sensation, and that all of the patients studied complained of appetite and weight loss, resulting in poor overall health. Umami taste receptors also reportedly exist in the gut, suggesting that the umami taste sensation functions in nutrient sensation and modulating digestion in the gut, which could be important for maintaining a healthy daily life.

The researchers suggest that diseases suffered by elderly patients and side effects from their medications could cause taste disorders and reduced salivation. They also found that treatment to improve salivary flow had a beneficial effect on the patients' taste sensations and could help patients with reduced umami sensitivity.

'Kokumi' substances, as found in garlic, onions and scallops, are known to enhance basic tastes when combined with other flavours, despite having no taste themselves. In a study of 29 people, published in *Flavour*, researchers showed that the addition of a kokumi substance significantly enhanced thick flavour, aftertaste, and oiliness in reduced-fat peanut butter. This suggests that kokumi substances could improve the flavour of low-fat foods.

BioMed Central



Members of the Danish and Moravian missionary formed the Society of the United Brothers with the primary objective of studying the natural history of the place.

reference books of the highest merit used for identification.

The subjects collected by Koenig and his colleagues are referred to as "Tranquebar Collections". They are still held in high esteem and most of them were type specimens (specimens based on which descriptions and naming of a particular genus and species is done) in museums across the world, for instance,



the Natural History Museum, London, Royal Botanic Gardens, Kew, Linnaean Collection in the University of Uppsala, Natural History Museum of Copenhagen, museum collection of University of Kiel, etc.

The place that opened the gates of the scientific study of Indian biodiversity was mauled by the Tsunami in December 2004. Though it is no more the hub of the systematic studies on Indian biodiversity, it will stand etched in the memory of every naturalist.

Contributed by N. Chitra, K. Gunathilagaraj and R.P. Soundararajan, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu; Email: chitra_bookworm@yahoo.com

NOW THREE PARENT BABIES!

MITOCHONDRIAL replacement is now a new biotechnological breakthrough which could result into births of three-parent babies. Moms can now give birth to offspring completely devoid of rare mitochondrial DNA mutations which result into certain diseases including diabetes mellitus, deafness and some heart and liver conditions.

Mitochondrion is the cell's power house which contains a small amount of DNA (mtDNA) inherited exclusively from the mother. Mitochondrial DNA makes up less than 0.1 percent of the entire human genome and contains just 37 genes. Mutations in mtDNA have been found to be present in about one in 5,000 live births and could lead to diseases that cause vision loss, seizures and premature deaths even.

The procedure of mitochondrial replacement i.e. three-parent in vitro fertilization (TPIVF), involves genetic material obtained from a mother, father and a female donor and carried out in a laboratory dish. The donor provides an egg having mutation-free mitochondrial DNA. The nucleus of that egg is extracted and mom's nuclear DNA—which, along with the father's DNA, comprising the genetic instructions that shape the progeny—is inserted in its place. Here the donor egg is fertilized by the father's sperm, involving both the mutation-free donor's mitochondrial DNA and mother's nuclear DNA. Like any other in vitro fertilization procedure, the fertilized egg is then implanted inside the mother.

However, the U.S. Food and Drug Administration (FDA) recently concluded that more studies must be performed before the procedure of mitochondrial replacement could be offered to needy mothers. There are certain uncomfortable questions being raised, such as whether or not fragments of residual mutated mitochondrial DNA could cause any health problems for the future generations. Though the primate species born via this method have survived into adulthood, no studies have yet tracked the future generations of their offspring.

The U.K. has taken the first step toward approval of the technique. While British legislators in the lower chamber of parliament agreed to the procedure by a majority, U.S. regulators have agreed to a go-slow strategy. Public furore understandably is still wrapped up in worries about designer babies. The argument is that if clinicians can alter embryos in this way, would not they eventually go for selection of other genetic material to make smarter, stronger, more attractive progeny?

Executive director of the USA Center for Genetics and Society Marcy Darnovsky warns that the known risks and areas of disturbing uncertainty are too large to permit clinical trials of the technique. The U.S. Institute of Medicine (IOM) is given a task to produce a consensus report exploring the ethical and social policy issues over the issue. In U.K. too, the House of Lords has still not passed the provision. China has prohibited the technique after a woman tried to undergo the procedure.

Yet another ethical concern is psychological and emotional impacts on a child's life with regard to a person's sense of identity. It is further debatable whether the genetic make-up of kids born as a result of three parent in vitro fertilization (TPIVF) affects their emotional well-being when they are aware that they are different from others conceived from the usual two parents.

Contributed by Dr. Arvind Mishra, Secretary, Indian Science Fiction Writers' Association, Meghdoot Mansion, Telitara, P.O. Baksha, District Jaunpur, U.P.-222108

GOING NUTS!



probably through their anti-oxidative, anti-inflammatory and endothelial function maintenance properties."

While research has previously linked nut consumption with lower mortality, those studies focused mainly on higher-income, white populations. This study was the first to discover that all races – blacks, whites and Asians alike – could potentially increase heart health by eating nuts and peanuts.

Participants included more than 70,000 Americans of African and European descent from the Southern Community Cohort Study (SCCS), who were mostly low-income, and more than 130,000 Chinese from the Shanghai Women's Health Study (SWHS) and the Shanghai Men's Health Study (SMHS).

Peanut consumption was associated with decreased total mortality, particularly cardiovascular mortality (i.e., 17-21 percent reduction in total mortality, and 23-38 percent reduction in cardiovascular

mortality for the highest quartile intake group compared to the lowest quartile group) across all three racial/ethnic groups, among both men and women, and among individuals from low-SES groups.

Because peanuts are much less expensive than tree nuts, as well as more widely available to people of all races and all socioeconomic backgrounds, increasing peanut consumption may provide a potentially cost-efficient approach to improving cardiovascular health, Shu said. "The findings from this new study, however, reinforce earlier research suggesting health benefits from eating nuts, and thus are quite encouraging."

The American Heart Association recommends eating four servings of unsalted, unroasted nuts a week. However, nutrient-rich nuts are also high in calories, so don't eat too many if you're watching your weight. A serving size is a small handful or 1.5 ounces of whole nuts or 2 tablespoons of nut butter.



RESEARCHERS at Vanderbilt University and the Shanghai Cancer Institute have found that intake of peanuts was associated with fewer deaths, especially from heart disease.

Senior author Xiao-Ou Shu says, "Nuts are rich in nutrients, such as unsaturated fatty acids, fiber, vitamins, phenolic antioxidants, arginine and other phytochemicals. All of them are known to be beneficial to cardiovascular health,

HARNESSING SOLAR POWER OVER GUJARAT CANALS

INDIAN officials have developed a unique approach to solar development, building a 4-km stretch of solar panels atop a canal near the western city of Vadodara, which not only saves arable land but also reduces evaporation of scarce water.

"Looking out at the canal top solar power plant, I saw more than glittering panels – I saw the future of India and the future of our world," Ban said. "I saw India's bright creativity, ingenuity and cutting-edge technology."

The plant is a part of the massive

hour. It is expected to produce over 16 million units in the first year. Generation is expected to decline by 1 percent per year as the solar panels degrade.

The solar photo voltaic (PV) cells produce direct current (DC) that has to be converted into alternate current (AC) for industrial and domestic consumption. To distribute the electricity from the source, the AC also needs to be stepped up to over thousand volts by the transformer.

"The Vadodara canal plant has 14 converters and nine transformers," said the chief engineer, Umesh Chandra Jain.

The entire output is presently scheduled to be consumed by the Sardar Sarovar project itself, said S.S. Rathore, the project's chairman-cum-managing director.

Gujarat chief minister Ms Anandi B. Patel told the local media that the SSNNL was purchasing power from a different company, Gujarat Urja Vin Nigam Ltd, at the a cost of Rs 6.48 per unit, where prices were soaring annually. The new solar project is expected to generate power at rupees 7 per unit for a longer period. Ms Patel also pointed out that the project's construction atop a canal means there were no land acquisition costs.

It is also expected to prevent evaporation of around 90 million liters of water in a year. The engineers also say the running water beneath the panels provides cooling for power generation.

"The right approach to energy can drive progress on all three pillars of sustainable development: economic dynamism, social progress and environmental sustainability," the UN chief said.

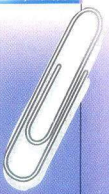
*Contributed by Er Nava Jyoti Thakuria, c/o DN Singh, Guwahati Press Club, Ambari, Guwahati-781001, Assam.
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navathakuria@gmail.com*



The 10-MW (megawatt) plant, apparently the first of its kind anywhere, was inaugurated by UN Secretary-General Ban Ki-moon. Erected over a 22-meter wide irrigation canal, the plant has 33,816 solar panels installed on a mounting over the water.

Sardar Sarovar project, a hydropower and irrigation scheme designed to supply water to 4.5 million acres of land through canals. The Rs 1 billion project is financed by the State government. On a sunny day, the habitually bright western Indian State generates 50,000 units of power per





More than 45 years back, the Concorde aircraft fulfilled a much-desired human fantasy – of flying faster than the speed of sound. But the Concorde's demise came sooner than expected.



Concorde

Supersonic Demise

FLYING at a speed faster than sound seemed incredible, until 2 March 1969, when the first supersonic aircraft – the Concorde – took to the skies and blasted its path into history.

When it first made its entry, the supersonic Concorde created a sensation in the era of commercial aviation. If you look at it simply, this meant a speed where if you utter a word, by the time your voice reaches your ears, the aircraft would have flown by you. With the advent of the Concorde any fare-paying passenger was in a position to fly at supersonic speed.

The almost legendary Concorde was a marvel. The aircraft could carry more than 100 passengers and crew from London to New York, a distance of more than 7100 km, within an unimaginable three hours while cruising at an altitude

of more than 18 km in the atmosphere (this was almost double the height at which commercial airplanes flew) with a mindboggling speed of about 2150 km per hour.

Concorde was designed and manufactured entirely in Europe by a consortium of U.K. and France, and the first successful flight took place on 2 March 1969. The word Concorde in French (same as its English equivalent, 'Concord') means agreement, harmony or union.

This was the time when modern computers and modern electronics were almost non-existent or at least not so developed. The entire designing and construction of this marvelous aircraft was done on the basis of mechanical, electrical, pneumatic or hydraulic principles. Although the designers used electronic technology, it was of


elementary nature. But they tried to achieve the maximum out of the available electronics. The aircraft was regarded by many people as an aviation icon and an engineering wonder.

This was the first civilian supersonic aircraft (Supersonic Transport or SST) ever built in the history of civil aviation and there was a general feeling that perhaps this aircraft would revolutionize the entire concept of passenger flights. It also posed a European challenge to the United States of America, which so far had monopoly over the design and manufacture of large commercial aircraft.

In order to fly non-stop across the Atlantic Ocean, Concorde was developed to have the greatest supersonic range of any aircraft. This was achieved by a combination of engines which were highly efficient at supersonic speeds, a slender fuselage (main body of the

Concorde's final flight;

G-BOAF from Heathrow to Bristol, on 26 November 2003, www.wikipedia.com



In the history of civil aviation till date, the only supersonic aircraft to see regular commercial service have been the UK-French Concorde

aircraft) with high fineness ratio, and a complex wing shape for a high lift-to-drag ratio. This also required carrying only a modest payload and a high fuel capacity. The aircraft was trimmed with precision to avoid unnecessary drag.

Unfortunately, Concorde had to face a lot of trouble right from day one, and finally succumbed after great struggle with all the majestic Concorde planes totally disappearing from the world's skies from November 2003.

Unique Aircraft

Concorde was designed and produced with the dedicated efforts of France and U.K. during the 60s and 70s and was equipped with marvelous features, revolutionary techniques and novel ideas. The aircraft was the first aircraft based on the Fly-by-Wire technology as early as in 1969 which was later adopted worldwide in the A-320 aircraft in the late 80s.

Proposals to manufacture a supersonic passenger aircraft were

jointly started in 1962 by the famous aircraft manufacturing companies, the Aerospatiale of France (manufacturer of Airbus aircraft) and British Aircraft Corporation of U.K. (manufacturer of Jaguar). After spending a lot of money, labour and research, these companies were able to complete the aircraft within seven years of dedicated efforts.

The Concorde faced many challenges. The first and foremost was designing its body and engines that could withstand the problems of flying at a speed faster than sound.

The other challenge was the problem of heating. When any object passes through air at high speeds, air molecules are heated, and the heat is transferred to the object. A craft at hypersonic speeds reaches temperatures at which aluminium would melt, and the temperature differences between different parts of the craft would create enormous stresses. A new material had to be designed to withstand such temperatures and

temperature changes.

Not surprisingly, the Concorde made front-page headlines on newspapers worldwide. So far supersonic flights were supposed to be a monopoly of smaller single or two-seater Air Force aircraft, but nobody thought that a 125-seater passenger aircraft could also fly at such fantastic speeds. The manufacture of Concorde brought the European nations (particularly UK and France) at par with USA, which was known as the leader in the field of aviation.

Apart from UK and France, USA and USSR had also been trying to produce a supersonic aircraft during those days. USSR had even manufactured one such supersonic aircraft – TU144 – which however crashed during its very first appearance in 1973 at the Farnborough Air Show at France. USA had also suspended its SST (Supersonic Transport) plan due to high cost. Thus, Europe was extremely joyous with its success in commercial aviation.



Left: Cockpit of concorde.
www.wikipedia.com

This was the time when modern computers and modern electronics were almost non-existent or at least not so developed. The entire designing and construction of this marvelous aircraft was done on the basis of mechanical, electrical, pneumatic or hydraulic principles.

Concorde interior. The narrow fuselage permitted only 4 seats across the aircraft with limited headroom. www.wikipedia.com



Concorde Challenges

The Concorde had a length of 61 m (200 ft.), wing span of 24 m (80 ft.) and a maximum height of 11 m (37 ft.). The fully-laden weight of the aircraft (including fuel, cargo and passengers) was 200,000 kg. The aircraft could accommodate 125-130 passengers.

The wings of the aircraft were 'Delta shaped' and its nose was pointed and drooping, giving it the majestic look of an eagle hovering and descending on ground. The aircraft had the capability to straighten its nose during flights to reduce air drag. Concorde was the first commercial aircraft to employ hybrid circuits.

Powerful engines of Concorde (Olympus Engines) were designed and manufactured by Rolls-Royce of U.K. and SNECMA of France. There were four such engines fitted in the aircraft, each having a power of 38000 pounds, which were capable of blasting the aircraft to supersonic speeds.

A moveable nose was designed for the Concorde, which had the capability to droop down while on ground, and would be straightened during flight. So, if one looked at the aircraft on ground, it appeared as if a huge eagle was moving with its head down, and after take-off, the eagle raised its head.



Top left: Concorde's intake system, Left: Concorde rear undercarriage (images www.wikipedia.com)

The first successful test flight of Concorde was made on 2nd March 1969. Scheduled flight commercial services started in the year 1976.

Mach Speed & Sound Barrier

The speed of an aircraft closer or faster than the speed of sound is normally expressed in terms of 'Mach Number' and not in terms of kilometres or miles per hour. The Mach number is the ratio of the speed of the aircraft to the speed of sound.

For example, when the aircraft is flying at Mach 1, its speed is equal to the speed of sound. Thus, an aircraft flying at Mach 0.9 is traveling at 90% of the speed of sound (called Subsonic), and an aircraft travelling at Mach 2 is traveling at twice the speed of sound (known as Transonic or Supersonic). Mach number was named after the Austrian physicist Ernst Mach.

However, the speed of sound varies with the composition and temperature of the air. It decreases with altitude and increases with altitude, since gas molecules move more slowly at colder temperatures and faster through warmer air. The speed of sound on an average day at sea level under standard atmospheric conditions is approximately 1225 kilometres per hour. However, when the aircraft reaches at an altitude of 10,000 metres above ground level, sound speed becomes approximately 1090 km per hour. In other words, if an aircraft is flying near the ground level, it will reach

the speed of sound ('Mach 1') at 1225 km/h, and when it attains a height of 10,000 m it will be at 'Mach 1.13' or 1.13 times the speed of sound at the same speed of 1225 km/h.

When an object reaches close to the speed of sound, it starts facing one of the biggest hurdles known as the Sound Barrier, since air compression is extremely high at this speed. Thus, when an aircraft crosses the sound speed, it experiences a retarding force, which is practically like crossing a solid wall made of stones. A sonic boom is the sound associated with the shock waves created by an object traveling through the air faster than the speed of sound. Sonic booms generate enormous amounts of sound energy, sounding much like an explosion. These sound energy waves travel at the speed of sound, and as the speed of the object increases, the waves are forced together, or compressed, eventually merging into a single shock wave, which travels at the speed of sound. Since the boom is being generated continually as long as the aircraft is supersonic, the sonic boom will keep on getting generated till the aircraft is flying at or above the supersonic speed.

When an aircraft flies at supersonic speed near the ground, the noise created and pressure waves generated by the sonic boom can play havoc, resulting in a blasting noise that may cause damage to ears, break glass windows and cause damage to weak houses.



External view of Concorde's fuselage,
www.wikipedia.com

Challenging Design

All the Civil Airliners of the modern era, such as B-747, Airbus-320, etc. (with the exception of Concorde) fly at subsonic speeds of approximately 950 km/h, which is Mach number less than 1. Concorde on the other hand, was to fly at Mach 2 speed, which roughly equals 2,100 km/h. Therefore, it had to be designed to withstand problems associated with supersonic speed.

Air compression on the outer surfaces caused the cabin to heat up during flight. Every surface, such as windows and panels, was warm to the touch by the end of the flight. Besides engines, the hottest part of the structure of any supersonic aircraft, due to aerodynamic heating, is the nose. The engineers used a specially designed aluminium alloy known as Hiduminium R.R. 58 to overcome the problems.

Concorde went through two cycles of heating and cooling during a flight, first cooling down as it gained altitude, then heating up after going supersonic. The reverse happened when descending and slowing down. This had to be factored into the metallurgical and fatigue modelling. A test rig was built that repeatedly heated up a full-size section of the wing, and then cooled it, and periodically samples

of metal were taken for testing. The Concorde airframe was designed for a life of 45,000 flying hours.

Owing to air friction, as the plane travelled at supersonic speed, the fuselage would heat up and expand by as much as 300 mm (almost 1 ft). The most obvious manifestation of this was a gap that opened up on the flight deck between the flight engineer's console and the bulkhead. The flight engineers would place their caps in this expanded gap, wedging the cap when it shrank again.

To keep the cabin cool, Concorde used the fuel as a heat sink for the heat from the air conditioning. The same method also cooled the hydraulics. During supersonic flight the surfaces forward from the cockpit became heated, and a visor was used to deflect much of this heat from directly reaching the cockpit.

The Concorde used reheat (afterburners) at takeoff and to pass through the upper transonic regime and to supersonic speeds, between Mach 0.95 and Mach 1.7. The afterburners were switched off at all other times. Due to jet engines being highly inefficient at low speeds, the Concorde burned two tonnes of fuel (almost 2% of the maximum fuel load) taxiing to the runway. Due to the

high thrust produced even with the engines at idle, only the two outer engines were run after landing for easier taxiing.

Another interesting feature of Concorde was its 'Nose', a long pointed nose that obstructed the view during ground movement of the aircraft (i.e. during taxi, takeoff, and landing operations). On the other hand, during flights, the nose was required to be straightened to reduce drag and achieve optimum aerodynamic efficiency.

A moveable nose was designed for the Concorde, which had the capability to droop down while on ground, and would be straightened during flight. So, if one looked at the aircraft on ground, it appeared as if a huge eagle was moving with its head down, and after take-off, the eagle raised its head.

The Concorde would attain supersonic speed over the sea and oceanic area (that too on reaching above a particular altitude), and maintain subsonic speed over land areas.

A total of 20 Concorde aircraft were built in France and the United Kingdom; six of these were prototypes and development aircraft. Seven each were delivered to Air France and British Airways.

In 1976, the aircraft started

Concorde received the biggest jolt when they learnt that their dream aircraft was being discarded by various countries, oddly enough due to its fast speed. The other negative factors were high cost of operations and pollution caused due to high noise, sonic boom, etc.

Even after the passage of more than 11 years, no other aviation company has dared to enter the field of supersonic commercial aircraft.



The Concorde at the Auto & Technik Museum
Sinsheim, www.wikipedia.com



commercial operations. The Concorde started flying regular transatlantic flights from London Heathrow Airport and Paris to New York, Washington, Dulles and Barbados. It took less than half the time than other airliners.

The Demise

Soon after its launch, the creators of Concorde received the biggest jolt when they learnt that their dream aircraft was being discarded by various countries, oddly enough due to its fast speed. The other negative factors were high cost of operations and pollution caused due to high noise, sonic boom, etc. So, the biggest advantage of the aircraft – its supersonic speed – became its greatest discredit.

In India, during the early experimental flights of the Concorde aircraft in the 70s, when the aircraft made low supersonic flights near Kolhapur (Maharashtra), damage was observed in weaker buildings of the area and window panes got cracked. Similar reports were received from other countries too.

Initially, when the Concorde was introduced in the market, about 16 countries including Iran, Japan, China, Australia and Singapore were willing to purchase 74 Concorde aircraft. However, subsequently all these countries started backing out. Many countries even prohibited flights of the Concorde over their territories (which included India also) due to supersonic problems.

The fare of the Concorde was quite high as compared to normal airfare due to high operational costs. Ultimately, only two airlines were left in the world, which were using Concorde for passenger

When it first made its entry, the supersonic Concorde created a sensation in the era of commercial aviation.

flights. Naturally, these were British Airways and Air France – they had a total of nine Concorde aircraft with them.

Another problem with this aircraft was that the operational expenditure and original cost was more compared to normal subsonic aircraft. However, British Airways and Air France were of the view that many businessmen and affluent people might give importance to the fast speed that could cut down the hours between distant destinations and therefore would patronize these flights. However, the results were not very encouraging.

By 1979 (within four years of starting passenger flights), the nine Concorde aircraft belonging to these two airlines carried about 500,000 passengers averaging 500 passengers per week per aircraft. But by 1980, the two airlines suffered a loss of 47 million pounds. The estimated loss on the Concorde projects was about 420 million for UK and France by 1983.

By the end of the 21st Century, it almost became clear the these airlines could no longer withstand the blow dealt by the loss of its Concorde revenues, since most of the world airlines were already struggling to maintain their competitive edge and attract more high-paying customers. The manufacturers also could no longer bear the loss suffered on production of Concorde.

The final ending came on 26th November 2003 when the Concorde was officially retired from commercial service

and it became history. To keep the retired fleet of Concorde, a number of venues were selected including Grantley Adams Airport in Barbados, Airbus UK at Filton in Bristol, Manchester Airport, Sinsheim Auto & Technik Museum in Germany, Museum of Flight in Scotland, Heathrow Airport in London, Museum of Flight in Washington, USS Intrepid in New York, etc. In addition a lot of offers have come from fans of the Concorde who have purchased parts of their favourite aircraft as souvenirs by paying heavy amounts at auctions.

In the history of civil aviation till date, the only supersonic aircraft to see regular commercial service have been the UK-French Concorde (Russian Tupolev Tu-144 was another one, which, however, failed in its first demonstration flight itself). So, following the permanent retirement of Concorde, there are no remaining supersonic aircraft in commercial service.

Even after the passage of more than 11 years, no other aviation company has dared to enter the field of supersonic commercial aircraft. Perhaps, the Concorde could be the sole representative of its kind in the history of aviation for a long time to come.

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Underground Observatories Searching for Neutrinos

M.S.S. MURTHY

The India-based Neutrino Observatory (INO), with an investment of about Rs. 1350 crores, is being set up in an underground cavern in the Bodi Hills on the Western Ghats in Tamil Nadu's Theni district. When completed, this will be the biggest pure science project in India.

IMAGINE sitting in a cavern more than a thousand meters below the earth and observing the Sun, stars and supernovae! You may think it is crazy. But that is what astronomers at "neutrino observatories"

do. Just as optical telescopes on Earth analyse light received from the cosmic bodies, neutrino telescopes hunt for neutrinos streaming from stellar bodies to get a peek into their internal structure, energy producing mechanism and even their birth and death.

Now, what are neutrinos? In a type of radioactivity called beta-decay, the nucleus emits a beta particle (same as an electron) whose energy happens to be less than the energy lost by the nucleus in the process. So, it appeared that the process violated one of the most fundamental tenets of physics – the conservation of energy and momentum. No process known disobeys this principle.

Hence, to come out of this puzzle, Wolfgang Pauli, the Austrian-Swiss physicist suggested way back in 1930 that a second unseen particle, electrically neutral (because charge was conserved) and mass almost zero is also

Wolfgang Pauli (center) with Adolf Friedrich Johann Butenandt and Sir C. V. Raman 1956.

<http://www.solid.eths.ch/~pauli>

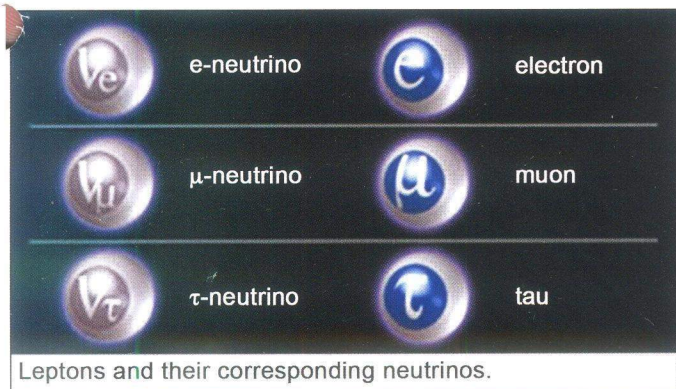
emitted and this particle carries away the missing energy. This meant that the total energy of the two particles remained constant and equalled the energy lost by the decaying nucleus thus satisfying the conservation laws.

Neutrons, with charge zero and mass almost equal to that of a proton, as a component of atomic nucleus were discovered in 1932. Enrico Fermi, an Italian scientist, called the particle proposed by Pauli the "neutrino" ("the little neutral one" in Italian) and formulated the theory of beta-decay around these particles. In this theory a neutron in the radioactive nucleus converts itself into a proton with simultaneous emission of a beta particle and a high speed neutrino:



In another type of radioactive beta-decay, a proton converts itself to neutron and emits a positron (an anti-particle of electron with same mass but opposite charge – positive) and a neutrino. In fact, the neutrino associated with the electron is known as antineutrino, while that associated with the positron is known as just the neutrino. In addition to natural radioactivity, beta-decay of fission products generated in nuclear reactors also produces large numbers of neutrinos.





Electrons belong to the family of fundamental particles called leptons. The other members of the lepton family are muons and tau particles, which, unlike electrons, are highly unstable. Each of these particles has its counterpart – an antiparticle. Researchers studying the decay of muons and tau also had to assume the emission of neutrinos for conservation of energy and momentum. Hence, we now have three types (or flavours) of neutrinos, corresponding to the three leptons: electron-neutrinos, muon-neutrinos, and tau-neutrinos.

Other Sources of Neutrinos

Apart from radioactivity, there are a number of other sources of neutrinos. According to the theory developed by the German scientists Hans Bethe and Carl Friedrich von Weizsacker, the source of energy of the Sun is a process known as nuclear fusion in which ultimately four protons (hydrogen nuclei) fuse together to form a helium (^4He) nucleus releasing an enormous amount of energy. In the process two protons are converted to two neutrons releasing two neutrinos.

To generate the energy at the present rate, the Sun produces 1038 helium nuclei per second and so twice that number of neutrinos. These stream out from the solar body in all directions at almost the speed of light. It is estimated that the Earth intercepts about 70 billion solar neutrinos per square cm every second!

Similarly, all stars and supernovae produce copious amounts of neutrinos. In fact, a supernova can unleash 1000 times more neutrinos than the Sun will produce in its ten billion years lifetime!

Earth's atmosphere is another important source of neutrinos. When cosmic ray protons, originating mostly from outer space enter the Earth's atmosphere, they interact with the

gas molecules to produce muons and muon-neutrinos. In addition, neutrinos produced during the Big-Bang, about 13.5 billion years ago are still around, circulating freely around the universe. Thus, neutrinos turn out to be one of the most abundant particles in the universe, next only to the photons. In fact in each of these systems, the neutrinos are so numerous that they take away a respectable proportion of the energy generated in the system.

When neutrinos were first proposed in 1930, it was only a hypothetical particle. Being chargeless and almost massless, and moving at almost the speed of light, it hardly interacts with matter and hence cannot be detected directly. It passes unhindered through the Sun, the stars, the Earth and everything else and so is rightly referred to as the "ghost particle". In fact, Wolfgang Pauli is credited to have said in exasperation, "I have done a terrible thing. I have postulated a particle that cannot be detected." It is this property of neutrinos that makes them special.

While the information carried by other signals like the electromagnetic waves degenerates because of their interaction with the matter through which they pass, the information carried by neutrinos remains pristine. With such a vanishingly small probability of interaction, to have even a small chance of recording a neutrino interaction, the detector has to be massive.

While even hand-held detectors can easily detect other particles like protons, beta particles, etc., neutrino detectors weigh several tons and occupy huge space. Not only that, in any arrangement to detect neutrinos on the surface of the Earth, the cosmic ray signals will be so numerous, they will simply swamp the signals, if any, from the neutrinos. Hence, to improve the signal-to-noise ratio even to a tolerable level, neutrino detectors

"Our neighbour could even beat us in some seminal discovery....and the Indian scientific community will face greater difficulty in securing future projects involving foreign collaboration because we can't deliver on time".

have to be placed deep underground where cosmic rays cannot reach, and are shielded from Earth's radioactivity.

Hence, the experimental detection of neutrinos remained a challenge for a long time. The first experimental detection was achieved only in 1956 by Clyde L. Cowan and Frederick Reines, twenty six years after it was postulated! The neutrino interaction scheme chosen by Cowan and Reines was very fascinating.

The target in the detector consisted of two tanks each with 200 litres of water mixed with 40 kg of cadmium chloride. The water tanks were sandwiched between three layers of scintillator material, isotropically surrounded by 1105 photomultiplier tubes to detect the light photons emitted from the scintillator. They placed the entire system, properly shielded from cosmic radiation, about 11 meters from a powerful nuclear reactor and 12 meters underground. During one of the rare interactions, a neutrino is absorbed by a proton in the water molecule and turns into a neutron, at the same time emitting a positron (e^+).

This positron quickly annihilates with its matter counterpart – the electron – releasing two gamma photons of 0.51 MeV in exactly opposite directions. These photons are promptly detected by the electronic circuits in the system. Microseconds later, the neutron is captured by the cadmium atom, releasing several gamma photons, which are counted separately. The actual detection of these photons, expected on the basis of a possible neutrino interaction, firmly established the existence of the neutrino for the first time.

Frederick Reines was honoured with the Nobel Prize in Physics in 1995. The Nobel Committee noted, "This was a pioneering contribution that opened the doors to the region of 'impossible' neutrino experiments."

Earth's atmosphere is another important source of neutrinos.

With the successful detection of neutrinos from one source, astronomers turned to solar neutrinos. Though theory states that nuclear fusion drives the process of energy production in the Sun and stars, it has not been possible to prove that. No probe can peep into the interior of the Sun and stars to see what is happening there.

Based on the Sun's luminous output, size, mass, core temperature, etc., scientists developed what is called a 'Standard Solar Model' to calculate the flux of solar neutrinos expected to arrive at the Earth's surface. In 1967 Raymond Davis of the University of California started a heroic effort to check this.

He set up a neutrino observatory at 1.5 km underground in the Homestake Gold Mine near Lead, South Dakota, USA. As described in the book *Sun, Earth and Sky* by Kenneth Lang, the detector consisted of 378 tons of a cleaning fluid – perchloroethylene. Perchloroethylene consists of two carbon atoms and four chlorine atoms. Most of the solar neutrinos pass through the detector unhindered. Occasionally, however, a neutrino with energy more than 0.814 MeV may hit the nucleus of a chlorine atom, turning one of its neutrons into a proton and simultaneously emitting an electron.

The hit chlorine atom no longer remains a chlorine atom, but transmutes into a radioactive argon atom and breaks off from the perchloroethylene molecule into the surrounding liquid. Because argon is chemically inert it does not react with the liquid, but can be extracted by bubbling helium gas through the liquid. The number of recovered argon atoms, identified by its characteristic radioactivity is a measure of the incident flux of neutrinos above 0.814 MeV.

Given the rarity of the neutrino interaction, it was not an easy job. Every few months Davis and his colleagues flushed the tank of an Olympic-size swimming pool with helium, extracting about 15 argon atoms! Over the next thirty years they were able to capture just about 2000 argon atoms which were enough to provide evidence for the type of fusion that was indeed going on in the Sun's core.

The Oscillating Neutrinos

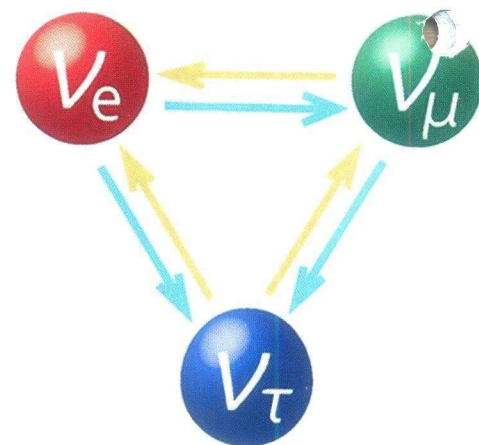
Though Raymond Davis succeeded in detecting the products of solar neutrino interaction, there was an unexpected problem. The detector always yielded results in conflict with the most accurate theoretical calculations. The solar neutrinos detected were about a third to half of what was expected. Subsequent experiments by others, even using different types of detectors in different settings confirmed this deficit. The big question was: Is the mechanism by which the Sun shines different from that predicted by theory? Or are there some processes preventing all neutrinos from being detected?

In an attempt to explain this puzzling deficit, astronomers discovered a new property of neutrinos. In their long journey from the Sun's core to the detector underground, some of the solar neutrinos, which are all electron-neutrinos, were transforming themselves to other forms (or flavours) of neutrinos escaping detection. That is, they were morphing to muon-neutrinos and tau-neutrinos – a property called "neutrino oscillation". Later experiments with detectors which can respond to all three flavours of neutrinos confirmed this phenomenon of neutrino oscillation and found that after accounting for oscillation, the number of neutrinos from the Sun was in agreement with the theoretical predictions.

It is now known that all three flavours of neutrinos can morph into each other. This opens up another aspect of neutrinos – their mass. Beginning with Wolfgang Pauli, it was assumed that neutrinos are almost massless. But neutrino oscillation requires that they have finite mass.

The implications of neutrinos having mass are far reaching. Given the unimaginably large number of neutrinos flooding the universe, their mass, however tiny, will have a great influence on the total mass of the universe and its evolution. How much is the mass of a neutrino? Do all flavours of neutrinos have the same mass? Because they pass almost unscathed through the celestial object where they are generated, do they carry some unique information about the celestial body's internal structure, composition, energy producing mechanism, its birth, death, etc?

There is also speculation that neutrinos may account for the "missing mass" or the "dark matter", which



Neutrino oscillation –

The three flavours of neutrinos morph into one another

constitutes a greater part of the matter in the universe. To answer these and many more questions astronomers have built more than thirty underground neutrino observatories and experimental facilities around the world.

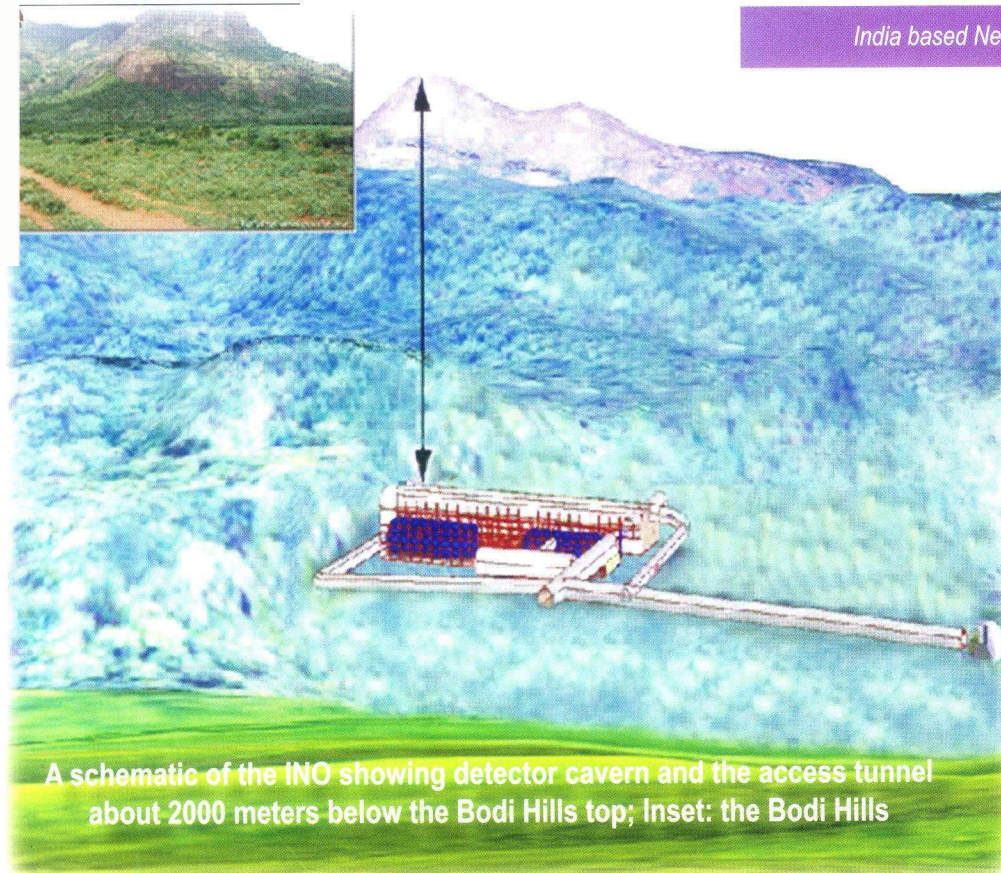
Some of the noted among them are the Super-Kamiokande built a kilometre underground in a Japanese zinc mine; Sudbury Neutrino Observatory – a collaboration of Canadian, British and American scientists, located 1.5 km underground in nickel mine in Sudbury, Ontario, Canada; and Daya Bay Neutrino Experiment, China.

India-based Neutrino Observatory

India has a long history of neutrino observation. As early as in the 1960s scientists from the Tata Institute of Fundamental Research (TIFR), Mumbai had set up a neutrino observatory at a depth of 2000 meters in the gold mines of Kolar to observe the atmospheric neutrinos. A collaboration of particle physicists from TIFR, Osaka University of Japan and Durham University, UK recorded the first cosmic ray neutrino interaction in this underground facility in Kolar.

However, with the closure of the mines the project had to be abandoned in the 1990s. In 1998, physicists from the Institute of Mathematical Sciences, Chennai studied the mathematical parameters in connection with neutrino oscillation, which were later confirmed by the Daya Bay Neutrino Experiment in China.

Now scientists from TIFR and 26 participating institutions in the country



A schematic of the INO showing detector cavern and the access tunnel about 2000 meters below the Bodi Hills top; Inset: the Bodi Hills

have proposed a new facility called India-based Neutrino Observatory (INO) with an investment of about Rs. 1350 crores, jointly funded by the Department of Atomic Energy and the Department of Science and Technology. The proposal has been included in the 12th Five Year Plan. Cabinet approved the project on 5th January 2015 and the excavation work will begin soon. When completed, this will be the biggest pure science project in India.

According to the INO web site <http://www.ino.tifr.res.in/> and <http://www.imsc.res.in/~ino> the Observatory will be set up in an underground cavern with a rock cover of more than 1000 meters from all sides in the Bodi Hills on the Western Ghats in Tamil Nadu's Theni district, about 100 km from Madurai. Two caverns will be made inside the hill—one to house the detector and the other as the control room. A 2km tunnel will connect them to the portals outside the hill where other experimental facilities will be situated. About thirty scientists will be working there at any time.

The Observatory will study the neutrinos produced by cosmic rays in the Earth's atmosphere with an aim to make

precision measurements of the parameters related to neutrino oscillations. Cosmic rays, mostly protons, interact with the oxygen and nitrogen molecules in the Earth's atmosphere and produce a type of negatively charged particle called pions (π^-). Pions (π^-), being extremely short-lived (life time 2.8×10^{-8} s), soon decay into muons (μ^-) and muon-neutrinos.

Subsequently, muons (μ^-) will also decay into muon neutrinos, electrons and electron anti-neutrinos. Thus, the atmospheric neutrinos will mostly contain muon neutrinos and electron neutrinos. While all the charged particles further interact on their way, lose energy and finally come to a stop, neutrinos, being weakly interacting pass right through the Earth. A few of them interact with the detector on their way.

The detector will be a huge iron calorimeter (ICAL), 150 layers of iron plates. These are interleaved with what are called glass resistive plate chambers (RPCs) more than 30,000 in number. By winding coils solenoidally around the iron plates and passing a current through them a uniform magnetic field of 1.2 to 1.3 tesla could be created inside the detector. In the final form the entire

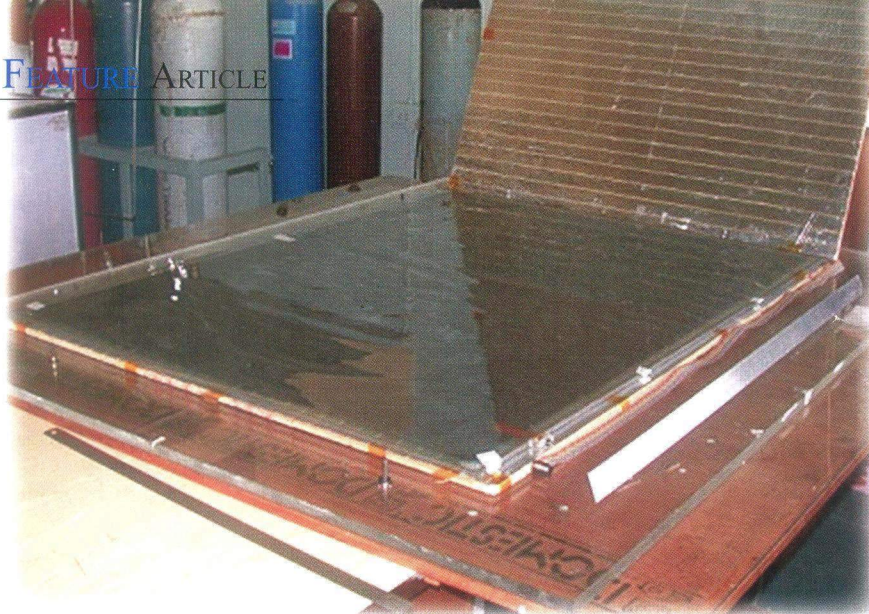
detector will measure 48 m X 16 m X 14.5 m and weigh 50,000 tonnes. It will be the largest electromagnet – more massive than the 12,500 tonne magnet in the Compact Muon Solenoid detector at CERN in Geneva, Switzerland, which was involved in the discovery of Higgs boson in July 2012.

The iron plates in the calorimeter provide a large mass as well as high density for the neutrinos to interact. Charged particles such as muons and electrons produced in such interactions will be detected in the RPCs sandwiched between the successive layers of iron. The charged particles bend in the detector's magnetic field, with oppositely charged particles bending in opposite directions. This will not only allow identification of their charge (+/-), but also provide

a good measurement of their energy and momentum. From such data scientists can infer the properties of the neutrinos that generated them.

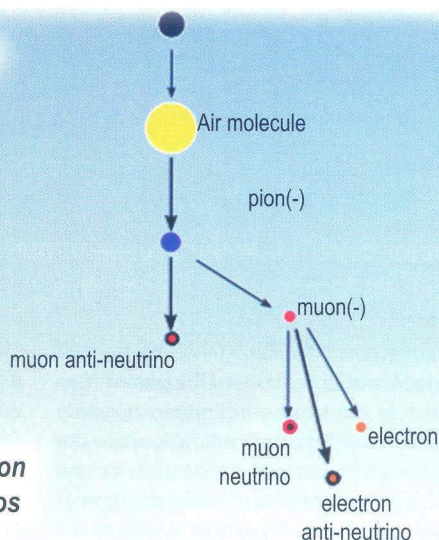
According to neutrino experts, the probability of neutrino oscillation depends upon the distance neutrinos have travelled to reach the detector and their energy. Hence, atmospheric neutrinos coming from the top of the Earth will have travelled less distance through the Earth and have lower probability of oscillation than those coming from the other end of the Earth. Thus, separate measurement of neutrino signals coming from the top and the bottom side of the detector would give an indication of the oscillation probability.

According to Prof. N.K. Mondal, the ability of the detector to track the particles in the magnetic field offers an exciting possibility of determining the ordering of the neutrino masses, which is not very well known at present. This is one of the fundamental questions in neutrino physics, waiting for an answer. Because of this unique ability of the detector, the INO has attracted considerable interest from the international neutrino community for collaboration.



Left: A prototype RPC detector under test at TIFR Mumbai.

Primary Cosmic Rays (mostly protons)



Atmospheric production of muon neutrinos and electron neutrinos

Apart from pursuing neutrino physics goals, the laboratory will greatly aid the development of detector technology and its varied applications. In the later years the facility can also be used in what is called "Long-base-line neutrino experiments" in which neutrino beams produced in accelerators located in Japan, Europe or USA are directed to this detector for further studies. Furthermore, the INO laboratory's design permits it to also host dark-matter decay experiments, which is another exciting area of astrophysics.

Meanwhile, scientists at TIFR have been working on the prototype detector to optimise its design. Sadly there has been an inordinate delay in the project. The delay has been caused by bureaucratic procedures and environmental activists, who have totally misunderstood the entire concept of INO.

When the project proposal was first placed for environmental clearance, the

Tamil Nadu State Environmental Impact Assessment Authority listed the project under the category "Industry: Nuclear power plants, fuel processing plants, and nuclear waste management plants". It took quite some effort on the part of the project managers to have this erroneous categorization corrected. However, the damage was done.

Ill-informed environmental activists are telling local people that the project involves nuclear weapons, storage of radioactive waste, exposing people to high levels of radiation which may cause cancer and birth defects, cause disturbance to wild animals and damage to nearby dams during excavation, and so on.

Prof. N.K. Mondal, through the INO website, has answered each one of these questions and emphatically denied that the project has anything to do with nuclear weapons and radioactivity. He

points out that the Observatory does not produce neutrinos but only detects those that are always present due to natural processes. When billions and billions of neutrinos pass through the human body every second and hardly one or two may interact with the body cells in an individual's lifetime, the question of health hazards from neutrinos does not arise at all.

Some political leaders have even alleged that India and the United States are making secret moves to conduct neutrino experiments deep inside the mountainous terrain of Idukki and Theni districts on the Kerala-Tamil Nadu border as a part of the Indo-US nuclear deal. Although the Tamil Nadu government's clearance had been sought for the project, no such effort had been made in Kerala's case, he alleged.

Contrast this with the statement issued by the Governor of South Dakota, USA, where an underground solar neutrino observatory was established years ago and is now the home for dark matter experiments. He says his state is proud to play a role in this important research and "congratulate the researchers and look forward to working with dark matter scientists and other partners in the years to come".

Recently, China announced that it is starting construction of its second neutrino research laboratory – the Jiangmen Underground Neutrino Observatory (JUNO) – which is expected to be complete in just six years, by 2020. INO and JUNO pursue a common goal.

Prof. Mondal fears that should our project face more roadblocks, "our neighbour could even beat us in some seminal discovery...and the Indian scientific community will face greater difficulty in securing future projects involving foreign collaboration because we can't deliver on time". He hopes that they will be able to collect the first set of data at least by 2020.

(Much of the information on INO and the illustrations are sourced from the INO web site. This article has been vetted by two scientists involved in/familiar with the INO program).

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Biology: Ultimate Science of the 21st Century

Biology is fast becoming the science of the 21st century opening up a fair amount of career avenues.

It is said that science started with Mathematics. Much in the beginning of civilization, humans started counting and slowly moved on to complicated calculations.

From Mathematics slowly emerged Physics. You might remember major laws of physics, for example, the Archimedes principle that explains floating of objects on liquids was given more than 2000 years ago. Similarly, many of the standard laws regarding the solar system, gravitation, optics, electricity (Copernicus, Galileo, Pascal, Newton, Hooke, etc.) were given in the 16th-17th centuries.

All these basic science principles helped in making today's technology. For example, it will not be possible to imagine Mechanical Engineering working without the basic laws of motion given by Newton in the 17th century, or even our

Mangalyaan (Mars mission) working without the law of gravitation. Similarly, all the electronics devices we use today like computer or a mobile phone would not be possible without basic principles like Ohm's law given in the 19th century.

Technology emerges from basic knowledge. From Physics studies slowly human curiosity started exploring the chemical world around us ultimately resulting in the science of Chemistry. Boyle's law (given in 1662 by Robert Boyle) explains the behaviour of gases particularly relationship between pressure and volume, Charles's law (given in 1787 by Joseph Charles) gives the relationship between temperature and volume. And then you have Dalton's law of multiple proportions (1808, John Dalton), Avogadro's Law (1811), Gibb's equation (1876) and so on.

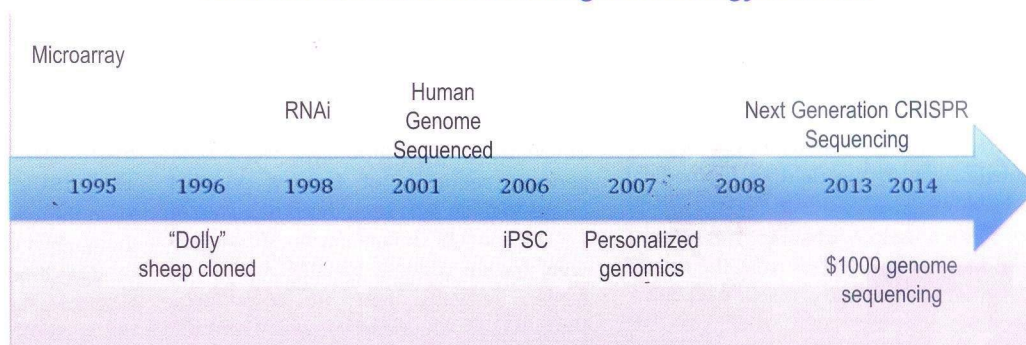
Many of these major discoveries happened during the 17th-19th century and today have resulted in different technologies. For example, nuclear energy would not be possible without a basic understanding of the atomic structure or so many chemicals regularly being synthesized in the laboratories including many life-saving drugs would not be possible without a basic understanding of chemical principles.

From the chemical understanding of non-living things around us, we have now started understanding the chemical basis of our own body. Now we can explain many biological processes at the molecular level.

But from a career perspective many students in India still find biology less attractive. They usually find job as a medical doctor or engineer much more attractive. But this is going to change to a great extent in the near future. Biology is going to be the science of the 21st century.

This biological detailed knowledge is already resulting in many technological inventions which affect our day-to-day life.

Time-line of recent breakthroughs in biology research





The Human Genome Project determined the sequence of all the bases in our genome's DNA and made maps that show the locations of genes on all our chromosomes.

Genetic information can be used to select the most appropriate drug to prescribe to a patient.

J. Craig Venter in 2007 became the first human whose entire diploid genome was sequenced

Although two of the great foundation studies in Biology, namely the study of evolution by Charles Darwin (1859) and Mendel's Laws of Genetics (1860s) were done in the 19th century, most of the molecular details (for example, Krebs cycle given by Krebs in 1940, the structure of DNA molecule given by Watson and Crick in 1953, genetic code given by Nurenberg and Ochoa in 1961, sequencing of DNA molecules by Sanger in 1975 and invention of the polymerase chain reaction, a method for multiplying DNA sequences outside a cell by Kary Mullis in 1980) were discovered in the 20th century.

This biological detailed knowledge is already resulting in many technological inventions which affect our day-to-day life. For example, genetically modified plants with better qualities are already in use and many medicines have been discovered based on this knowledge. So, Biology is moving at a great pace. With the emergence of new subjects like Bioinformatics, many computer scientists are also shifting to biology research. Similarly, the emergence of Synthetic Biology makes many Chemists to think about Biology. Many Mechanical or Electrical engineers are also making their contributions to the field of Biomedical Technology.

Let's now look at some examples of great biology discoveries from the last 20 years that have changed the way we think about Biology.

From Human Genome Project to Personalized Medicine

The Human Genome Project was an international, collaborative research programme whose goal was the complete mapping and understanding of all the genes of humans. The Human Genome Project determined the sequence of all the bases in our genome's DNA and made maps that show the locations of genes on all our chromosomes.

The International Human Genome Sequencing Consortium published the first draft of the human genome in the journal *Nature* in 2001. A surprising finding was that the number of human genes found (about 20500) was much less than previous estimates, which ranged from 50,000 genes to as many as 140,000.

The total cost of the human genome project was 2.7 billion US dollars (approximately 167 billion Indian rupees). Once the reference human genome was sequenced, technology soon developed to sequence the entire genome sequence of individual people. In 2007, the entire genome of J. Craig Venter, leading American scientist in genome research, was sequenced at a cost of 100 million US dollars (approximately 6 billion Indian rupees).

In 2008, with further advancements in sequencing technology, the entire genome sequence of famous scientist James Watson was sequenced at a cost of 1.5 million US dollars (approximately 9 crore Indian rupees). In 2014, with even further advancement in technology, Illumina, an American company and the

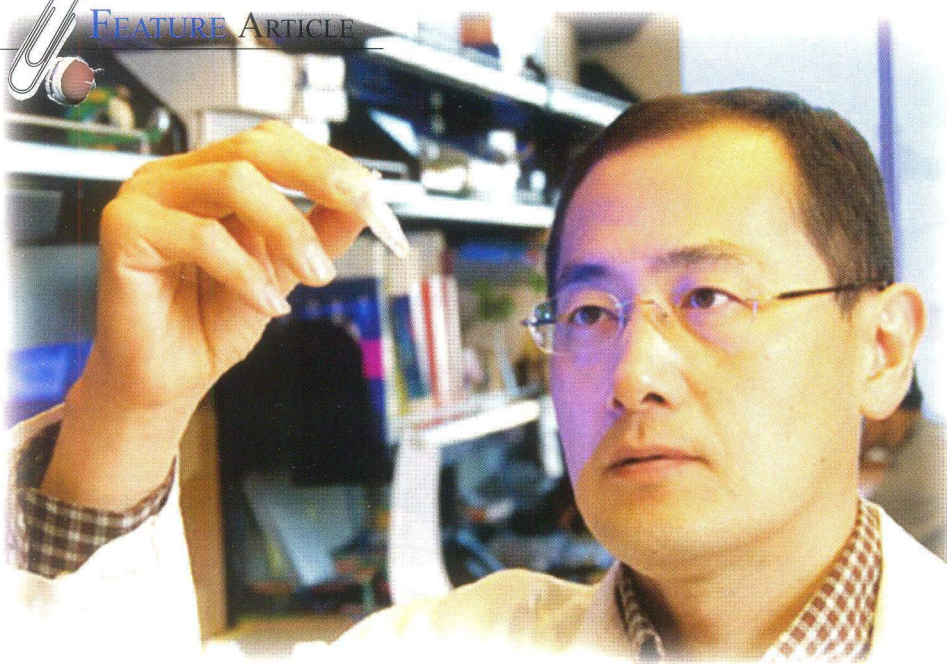
world's leading seller of gene sequencing machines, unveiled its HiSeq X machine. This machine can process 20,000 genomes per year at a cost of 1000 US dollars (approximately 60000 Indian rupees) each. It will not be surprising to have personal genome sequencing facilities available at a cost of Rs 1000 in the coming future.

One might wonder why sequence genome is important? Genetic information can be used to select the most appropriate drug to prescribe to a patient. The drug can be chosen to maximize the probability of obtaining the desired result and minimize the probability of side effects for the patient. Disease risk may be calculated based on genetic information for common medical conditions to prevent the disease or take appropriate care in advance.

For instance, if someone is susceptible to a cancer, diagnosis early can result in surgical removal of the tumour much before it spreads to other parts of the body. In India, the CSIR Institute of Genomics and Integrative Biology (IGIB), New Delhi has taken a lead in genome sequencing and a volunteer's genome can even be sequenced for free (for more information visit the website <http://www.meragenome.com/home>).

Signalling Mechanisms and Drug Targets

Even though all cells of our body contain the same genome, cells of different organs behave differently. A nerve cell conducts electrical signal while a pancreatic beta cell secretes hormone insulin that helps



Shinya Yamanaka discovered iPSCs in 2006 and was awarded Nobel Prize in Physiology or Medicine in 2012

Japanese scientist Shinya Yamanaka developed a method of inducing stem cell characteristic into skin cells by transferring of four genes in these cells using gene therapy. He called these cells induced pluripotent cells (iPSCs). These cells offered a great tool to understand human stem cell biology and also offered therapeutic promises.

in glucose metabolism. Some cells form bones while others circulate in the blood vessels in the form of immune cells to protect us from infection.

Why are these cells different despite having the same genome sequence in all of them? The answer to this question lies in the fact that genes themselves do not perform biochemical functions. First, a gene needs to be transcribed to mRNA in the nucleus of the cells; mRNA then travels to the cytoplasm of the cell where it is translated into a protein.

Proteins are the functional molecules of the body that perform many regulatory functions, for example, working like an enzyme to catalyze many biochemical reactions inside cells. Different proteins inside our cells communicate with each

other and help cells in different functions like growth, movement, secreting hormones, etc. Not all genes make proteins in all body cells.

Selective expression (transcription + translation) of different genes into proteins in different cells makes those cells unique. For example, hormone insulin is made by beta cells in the pancreas but not in the brain cells. Determining what proteins are made in different cells has been a very important question for scientists.

In 1995, a new technology called DNA microarray developed at Stanford University in USA made it possible to determine what mRNAs are made inside a cell at the whole genome scale. This technology revolutionized our understanding of signalling pathways

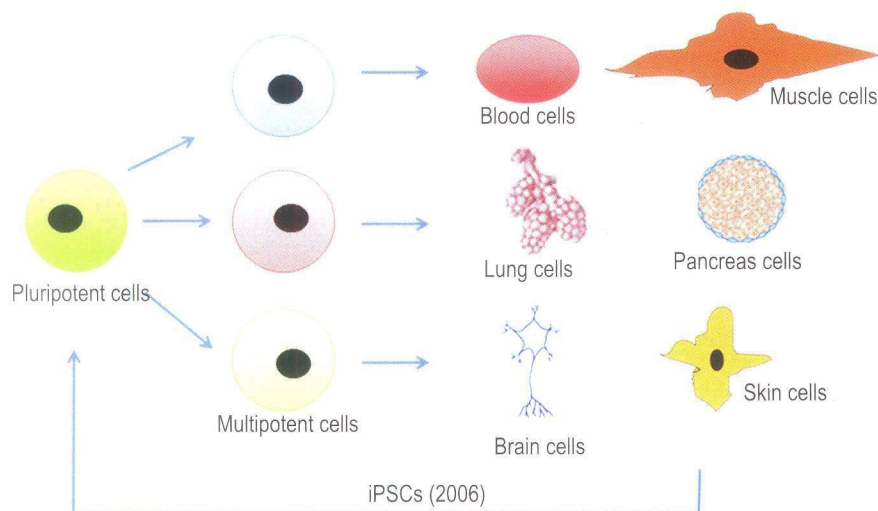
and also led to new drug targets for diseases. For example, by comparing the transcription profile of cancer and healthy cells one could get the idea about which proteins are made more in cancer cells compared to healthy cells and hence should be inhibited.

But there was an obvious limit to this technology. For this technique to work, we need to know in advance which genes we are looking for. Non-coding RNAs (RNAs that do not make proteins but might still function in some other way) could not be analyzed with this method. Recently, with advancement in sequencing technologies, DNA microarray is largely replaced by RNA sequencing (RNAseq). In RNAseq all the mRNAs in a cell type are directly sequenced without the need of any prior knowledge about them, thus overcoming the limitations of microarrays.

Another advancement in finding functions of different proteins, regulatory mechanisms and drug targets was the discovery of RNA interference technologies. Andrew Fire and Craig Mello, two American scientists, in 1998 discovered the phenomena of RNA interference (RNAi) in which small double-stranded RNA molecules can cleave mRNA and thus stop production of corresponding proteins. Both Andrew Fire and Craig Mello received the Nobel Prize in Physiology or Medicine in 2006 for their discovery.

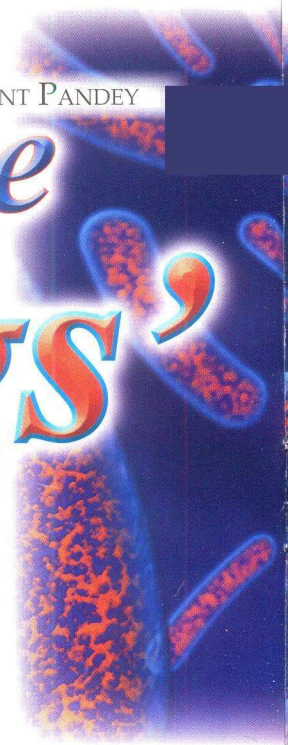
The naturally occurring phenomenon of RNAi was exploited by artificially targeting different genes and exploring their function. For example, if RNAi

All cells in our body arise from Pluripotent Embryonic Stem cells



The Quest to Tame 'Superbugs'

A new antibiotic has been discovered and mankind is on an urgent quest to discover more but the inconvenient truth is it is we humans who are responsible for the creation of the monster Superbugs.



SUPERBUGS or microbes resistant to antibiotics are at present the biggest and the greatest global health threat. Since this is no longer a mere distant threat the human race desperately needs new generation of antibiotics to not only fight the killer microbes but also a way to curtail their developing resistance to antibiotics. Unless this aim is achieved fast, routine operations and even minor infections could become fatal.

The World Health Organisation has also issued warnings regarding this emerging grim scenario. Recently, the British Prime Minister David Cameron urged for a coordinated effort between countries to find new antibiotics and warned the world community to act fast because we are looking at an almost unthinkable scenario where antibiotics no longer work and we are cast back into the dark ages of medicine where treatable infections and injuries will kill again. In India too sporadic cases of superbugs are showing up which is a cause for concern.

Recently the news of the discovery of a new antibiotic called 'Teixobactin' came as a great relief but the human race needs an arsenal of new antibiotics in its battle against the killer superbugs.

Super bugs in India

While the discovery of the new antibiotic fills us with hope against the battle with the superbugs, cases of the superbug's emergence in India have started trickling in, which is worrisome.

Colistin the last antibiotic in the arsenal of the medical fraternity is also no longer invincible. It is used when all or almost all other drugs fail. Here it should be noted that Colistin was used in the 1960s but its use was stopped owing to its toxicity four decades ago. Since 2005 Colistin is being used to treat severe multidrug-resistant gram negative bacterial infections, particularly among intensive care patients.

Though it is not a preferred antibiotic, in India doctors are left with little choice and are using it against Carbapenem-resistant infections. Carbapenem is a third generation antibiotic and belongs to the strongest class of antibiotics. It is used to treat cases resistant to lower drugs. Hospitals in our country are now recording cases of infections that are

incurable even by administering Colistin, which happens to be the last antibiotic available in the world.

The first ever evidence of pan-drug resistant cases has now been recorded by three Chennai-based doctors. Their paper titled Emergence of pan-drug resistance among gram-negative bacteria! The first case series from India was published in the December 2014 issue of *Journal of Microbiology and Infectious Diseases*.

The paper maps 13 cases recorded over 18 months and informs that tertiary care hospitals across the country are recording cases of infections that even Colistin is not able to treat. In Delhi hospitals the resistance was detected at 4 to 5%. In Pune's state-run Sassoon General Hospital, of the 799 drug-resistant bacteria tested between January and July of 2014, 36 were found to be Colistin-resistant. Stray cases have been reported at Ruby Hall clinic in Pune and doctors at Tata Memorial Hospital in Mumbai recall one case in the last three to four years.

A new antibiotic has been discovered and mankind is on an urgent quest to discover more but the inconvenient truth is it is we humans who are responsible for the creation of the monster called Superbug.





Patients who are advised antibiotics must remember to complete the prescribed antibiotic course.

The superbugs have taught us humans a very important lesson of not being careless, complacent and ignorant which we humans will do well to remember.

A New Antibiotic

Penicillin, the first antibiotic was discovered by Alexander Fleming in 1928. But since 1987, no new class of antibiotics has been discovered. The use of antibiotics gained massive popularity in the years following the Second World War. The most frightening diseases like syphilis, pneumonia, tuberculosis, bacterial meningitis, etc. started getting cured. This led to complacency in researches to find more new classes of antibiotics.

In the 1960s, researches into infectious diseases started getting less popular. In the 1970s, medical researchers were even claiming that humanity's victory over infectious diseases was just a matter of time. But this sweet dream came crashing down with the emergence of superbugs and human beings had to swallow the bitter truth that bacteria are cleverer than men.

Now, after a gap of around 28 years scientists have succeeded in creating a new class of antibiotics which if approved for use in humans, promises to deal with pathogens that are becoming resistant to the present lot of antibiotics in use.

The credit for the discovery of the new antibiotic goes to Professors Kim Lewis and Slava Epstein of North-Eastern University, Boston, USA and their colleagues from the University of Bonn in Germany, Novo Biotic Pharmaceuticals and Selcia Ltd in the UK. The findings of the researchers have been published in the journal *Nature*.

Experiments with teixobactin on mice have shown that it can successfully tackle pathogens such as the superbug MRSA (methicillin-resistant *Staphylococcus aureus*) as well as other bacterial infections such as tuberculosis, septicaemia, and *Clostridium difficile* colitis without having any side effects. Most importantly it eliminates pathogens without encountering any detectable resistance. According to the scientists, as most antibiotics target bacterial proteins the pathogens can become resistant to the drugs by evolving new kinds of proteins. The fact that sets the new found antibiotic apart from the rest is that it launches a double attack on the building blocks of bacterial cell walls.

It will be tested on humans soon and there are high hopes that the new antibiotic may be available for use in the next five years.

Quest to Put a Leash on Superbugs

Looking at nature for new antibiotics: Scientists are turning to nature in the quest to find out new antibiotics. They are looking at the depths of oceans or the driest of deserts or the insides of insects to come up with chemical novelties that may lead to discovery of new antibiotics.

Researchers at the John Innes Centre in Norway are working on the bacteria extracted from the stomachs of stick insects and Cinnabar caterpillar, which is known to have a liking for highly toxic

plants. They are also researching on the protective coats of the leaf-eater ants.

Scientists say that the guts of the stick insects or the protective coat of leaf-eater ants is a storehouse of endemic species of microbes that have developed unique ways to deal with the stresses of life including attacks from rival bugs.

Scientists from Lund University in Sweden have found that the lactic acid bacteria found in Honey bees could be an alternative to antibiotics. The group of bacteria counteracted MRSA in lab experiments. The bacteria blend has already been tested on horses and healed persistent wounds. Researchers have identified a unique group of 13 lactic acid bacteria found in fresh honey from the stomach of bees. The bacteria produce a myriad of active antimicrobial compounds. The bacteria were mixed with honey and applied to ten horses whose owners had tried several other methods to heal the wounds of the horses to no avail. All the wounds were healed by the mixture.

The researchers believe the secret to the strong results lie in the broad spectrum of active substances involved. According to Tobias Olofsson, professor of Medical Microbiology, "Antibiotics are mostly one active substance, effective against only a narrow spectrum of bacteria. When used alive, these 13 lactic acid bacteria produce the right kind of antimicrobial compounds as needed. But since store-bought honey doesn't contain



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the living lactic acid bacteria many of its unique properties have been lost in recent times."

On the other hand Marcel Jaspars, professor of organic chemistry at Britain's University of Aberdeen, is heading a 9.5 million Euros or \$12.7 million of European Union funding project called Pharmasea in which he and his team of international researchers will haul samples of mud and sediment from deep-sea trenches in the Pacific Ocean, the Arctic waters around Norway, and the Antarctic to search for never before seen bacteria for an answer to the superbugs.

Working on the same line, scientists from the US Rockefeller University have analysed soil from beaches, forests and deserts on five continents to discover the best places in the world to mine untapped antibiotic. The findings provide new insights into the natural world as well as a road map for future drug discovery. The scientists now want to collect more samples from unique environments like caves, hot springs, islands and city parks.

Lead author Zachary Charlop Powers said that the study of the biosynthetic content of these soils shows their potential for drug discovery. According to Sean Brady of the varsity, "Uncultured bacteria from the environment could provide a dazzling array of new molecules, many of which could become new medicines. The unbelievable diversity we found is the first step towards our dream of building a world map of chemicals produced by microbes." The scientists will continue with their citizen science effort 'Drugs from Dirt' inviting the public to submit samples.

Gene editing: Engineers from the Massachusetts Institute of Technology (MIT) have developed a new gene editing system that can selectively kill bacteria carrying harmful genes that confer antibiotic resistance or cause disease. Most antibiotics work by interfering with crucial functions such as cell division

or protein synthesis. However, some bacteria including the formidable MRSA (methicillin-resistant staphylococcus) and CRE (Carbapenem-resistant enterobacteriaceae) organisms have evolved to become virtually untreatable with existing drugs.

Timothy Liu, an associate professor at the MIT along with her two students Robert Citorik and Mark Mimee targeted specific genes that allow bacteria to survive antibiotic treatment. The CRISPR genome editing system presented the perfect strategy to go after those genes. The CRISPR involves a set of proteins that bacteria use to defend themselves against bacteriophages.

Software to predict how bacteria react to new drugs: Researchers from the Duke University have developed a unique computer software, which identifies genetic changes that allow bacteria to develop resistance to new experimental drugs. The researchers used the software to predict a constantly evolving bacterium's countermoves to one of these new drugs ahead of time, even before the drug is tested on patients.

The team used their programme to identify the genetic changes that will allow MRSA to develop resistance to a class of new experimental drugs that show promise against the deadly bug. When researchers treated live bacteria with the new drug, two of the genetic changes actually arose just as their algorithm predicted. Bruce Donald, professor of computer science and biochemistry at Duke and one of the co-authors of the study emphasises, "This gives us a window into the future to see what bacteria will do to evade drugs that we design before a drug is deployed."

Engineered cationic antimicrobial peptides: Researchers at the University of Pittsburgh Center for Vaccine Research (CVR) have pioneered a treatment far more effective than traditional antibiotics at inhibiting the growth of superbugs.

Professor at CVR, Ronald C. Montelaro and his colleagues have developed a synthetic version called engineered cationic antimicrobial peptide or 'eCAP' that can be synthesised in a lab setting. Cationic is a type of antimicrobial peptide which is a part of innate immune response and found among all classes of life.

The experiments conducted showed that eCAPs worked better than some of the best existing antibiotics including a natural microbial peptide made by nature. The eCAPs worked as effectively at killing *Pseudomonas aeruginosa* after it became resistant to the traditional drugs. According to Montelaro, "We plan to continue developing the eCAPs with the intention of creating the least toxic and most effective version possible so we can move them to clinical trials and help patients who have exhausted existing antibiotic options."

A new antibiotic has been discovered and mankind is on an urgent quest to discover more but the inconvenient truth is it is we humans who are responsible for the creation of the monster called Superbug. The over-prescription of antibiotics must be stopped and it should be used only when it is required. The habit of self treatment by taking antibiotics must be curtailed as well as the sale of over-the-counter antibiotics without a doctor's prescription must be stopped. Patients who are advised antibiotics must remember to complete the prescribed antibiotic course.

The superbugs have taught us humans a very important lesson of not being careless, complacent and ignorant which we humans will do well to remember. The answer to defeating the superbugs lies in our hands.

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Understanding DTH System

TELEVISION broadcasting has undergone significant changes during the last two decades. To begin with, TV broadcasting was through terrestrial transmission in the VHF band. Since this is line-of-sight communication, the coverage area is limited and for covering more regions many transmitters are required at different locations.

During the eighties, in India, with the launch of the INSAT satellites, the TV coverage was increased by installing Television Receive Only (TVRO) stations with low power transmitter (LPT) and high power transmitter (HPT). Here the TV programme was transmitted from Delhi through satellite and is received at various locations using antenna and receive electronics. The receive audio and video is retransmitted terrestrially in VHF band so that normal television receivers can receive it. LPT coverage is less as the transmitter power is less while HPT coverage is wider. Television coverage thus increased.

With the advent of satellite TV transmission, cable TV became popular in the nineties. Cable TV operators installed antennas and receivers to receive signals from the satellite. Separate receivers are used to demodulate each TV signal. Each

demodulated video and audio signal is modulated onto a separate frequency for transfer to the cable. The channel frequency and modulation plan is such that they can be received by the normal home TV receiver.

The frequencies are in VHF low, VHF high, superband, hyperband and in UHF band. The cables are routed to individual households and fed to the antenna socket of the TV receiver. In the earlier days, analogue transmission was used and only one TV channel was transmitted per transponder of the satellite. But today with digital transmission approximately almost 15 TV channels can be transmitted per transponder. Thus, from a satellite having 24 transponders, the cable operator can extract 360 channels for distribution.

Amplifiers are installed at appropriate distances along the cable route to maintain adequate signal quality. In the case of free-to-air channels, the cable is directly connected to the antenna socket of the TV receiver and in the case of pay channels it is connected through a set-top box. The subscriber will be authorized to receive the pay channel by the cable operator.

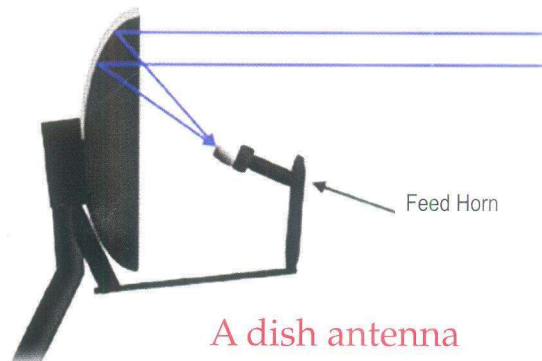
Next came Direct-to-Home (DTH) systems designed to transmit TV programmes directly to home receivers. The broadcaster directly connects to the user and the cable operator does not come into the picture.

The three elements in DTH system are the satellites in geostationary orbit used for transmission of signals, the broadcasting centre where the broadcaster (DTH operator) acquires video signals and transmits to the satellite, the users or subscribers who receive the signals directly from the satellite at their homes using a dish antenna and a set-top box.

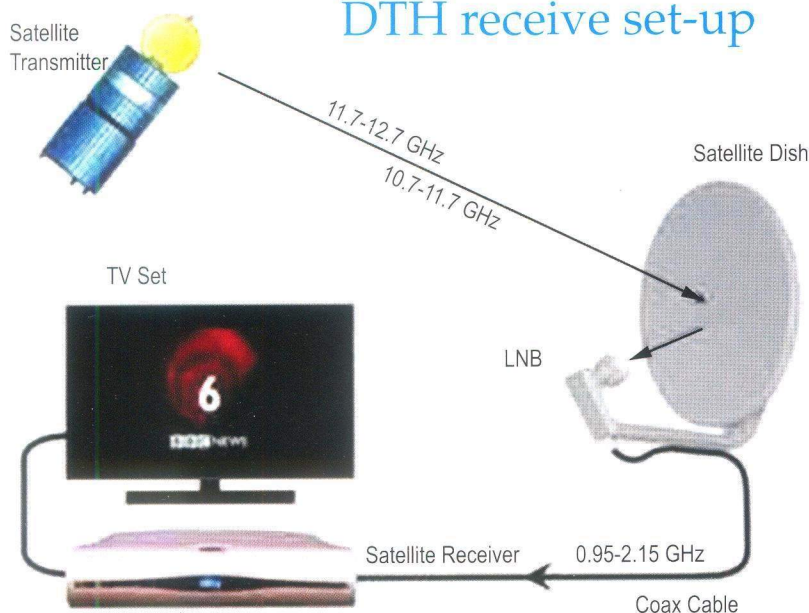
The satellite is a geostationary communication satellite, having a number of transponders (channels), orbiting at approximately 36000 kilometer above the equator. The satellite receives the signal transmitted by the broadcaster which is in the range of 14000 to 14500 MHz, converts this signal to the frequency range of 10700 to 12750 MHz, amplifies and retransmits towards the earth.

The transmitting power of the satellite will be such that one can use a 60-cm dish antenna on the ground to receive the signals. These frequencies are called Ku-band frequencies, which make high transmitting power from satellite possible. A small dish antenna can be used on the ground. The power from each transponder of the satellite is termed as Effective Isotropically Radiated Power (EIRP). The higher the EIRP, the more powerful is the satellite. Indian satellites like INSAT-4CR and GSAT-10 have approximately 50 dBWatt of EIRP per transponder in Ku-band frequencies.

The transmitting power of the satellite is such that one can use a 60-cm dish antenna on the ground to receive the signals. These frequencies are called Ku-band frequencies



DTH receive set-up



DTH operators transmit the video channels to the satellite and also supply the satellite receiver to the users/subscribers. They take the video signals either from other satellites or terrestrially through optical fibre cable. Each video and audio signal is fed to each encoder for digital compression. As the uncompressed video signal occupies more than 200 mega bits per second (MBPS), which requires large bandwidth for transmission, the encoder compresses the video data to about 2 to 5 MBPS using complex algorithms. The compression is achieved by reducing the redundancy in the signal and also by removing those components that will not be noticed by the human visual system.

In the data stream, service information is added which allows the decoder to tune to a particular service and also to provide on-screen menu of programmes called electronic programming guide (EPG). The programme is scrambled and encrypted so that only authorized subscribers can receive the signal. Each set-top box can be addressed by the broadcaster for receiving the desired channels.

Many broadcasters use advanced compression technology called MPEG-4. This cuts the bandwidth of TV signals to almost half of that used by MPEG-2. Thus, twice the number of channels per transponder can be transmitted. Though the compression ratio is more, the picture quality is not affected and remains almost the same.

The third element is the DTH receiver at the subscriber's premises, that

is, in your home. The receiver consists of a parabolic dish antenna of 50 or 60 cm diameter. This dish is mounted on a wall such that it "looks" at the required satellite. There should not be any obstruction like building or trees in the path between the antenna and the satellite.

The signal from the satellite is reflected by the parabolic dish towards a point called focus just like a concave mirror focuses the light. At the focus, a feed horn is mounted that collects the focused signal. At the feed horn is mounted an equipment known as low noise block converter (LNBC). This amplifies the receive signal and converts the Ku-band frequency to 950 MHz to 2150 MHz which is called the L-band. The dish antenna and feed horn with LNBC are outdoor units. The output of the LNBC is connected to the set-top box which is mounted inside the house through a cable.

The receiver decodes the encrypted signal. The digital MPEG-2 or MPEG-4 signal is converted to analogue format so that a standard television can recognize it. The video and audio output is connected to the AV input of the TV receiver.

The Ku-band signals used for DTH are affected by rain. The signal is absorbed by rain drops and hence the signal from the satellite is attenuated when it travels through rain. The signal becomes weak and the set-top box will not be able to decode and there will be loss of picture during rains. This is called rain loss or rain fade. The amount of loss of signal

depends on the rain rate (mm/hour).

Normally signal margin is built in the system to withstand some rain loss. If the loss is more than the margin, the picture will be lost. Similarly, in the broadcaster's station if there is rain, signal reaching the satellite will be less due to rain loss and to compensate this, the transmit power will be increased. This is achieved by uplink power control (UPC) system incorporated in the transmit station.

Some satellites have automatic gain control (AGC) system to keep the satellite transmit power constant. With this when there is rain in the transmit station, receive DTH systems will not be affected. Some broadcasters have two transmitting stations at geographically separated locations. Whenever there is heavy rain at one station, the other station will take over and since they are geographically separated, the probability of having rain simultaneously at both locations is very less. This is called space diversity technique.

Video-on-demand service can be provided in DTH system. The customer can select a movie from a large available video data base. Individual customers can watch different programmes they wish. Since each set top box can be addressed, special information as message can be delivered to individual viewers. For example, disaster warning like cyclone warning and heavy rain warning messages can be transmitted to set-top boxes situated in the cyclone/rain prone areas so that people can take precaution.

Though DTH was envisaged to serve in remote areas, it has become popular in city households also. In future DTH will be operating in Ka-band frequencies (17000 MHz to 21200 MHz and 21400 to 22200 MHz). With the saturation of available satellite spectrum in the Ku-band, attention has now turned to the relatively unused Ka-band frequencies. In these frequencies high bandwidth and high power spot beams will be available. Because of high bandwidth availability, it is possible to transmit high definition TV (HDTV). The rain loss will be more compared to Ku-band frequencies. But it is possible to have powerful satellites so that the service availability will be 99.95% in rain climatic zones.

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THE INDIAN SPACE STORY

REACHING FOR THE STARS: INDIA'S JOURNEY TO MARS AND BEYOND

by Pallava Bagla and Subhadra Menon, Bloomsbury Publishing India Pvt. Ltd., Vishrut Building, DDA Complex, Building No. 3, Pocket C-6 & 7, Vasant Kunj, New Delhi-110070; 2014, Pages 257; Price Rs 899/-; ISBN: 978-93-84052-32-4

Replete with interesting anecdotes the book will make for fascinating reading for anyone interested in an insight into one of the most professional organisations in the country. It will also be an eye-opener for the younger generation who would find the facts and stories inspiring.

India's space programme started on a modest scale in November 1963 with the launch of a small American Nike-Apache rocket from the newly built launching pad at Thumba. More than five decades later, the country's space ambitions have catapulted it to the Red Planet. And the country's space endeavours are focused to venture much beyond.

Dr. Vikram Sarabhai, lovingly called the father of India's space programme, was convinced that the newly emerging space technology offered solutions to many of the nagging problems that plagued a vast and economically backward country like India. "It is not the question of whether India can afford to invest in space research", he would say, "but whether she can afford not to invest in it."

Today, the country's five-decades-old space programme is one of the most visible success stories demonstrating unequivocally India's capability in high technology. It is a story that needs to be

told again and again. And that is what the husband-wife team of Pallava Bagla and Subhadra Menon has done yet again in their second book on the exploits of the Indian Space Research Organisation (ISRO).

While their first book, *Destination Moon: India's Quest for Moon, Mars & Beyond*, was written in the backdrop of India's maiden Moon mission, Chandrayaan-1, *Reaching for the Stars: India's Journey to Mars and Beyond* explores the Indian space programme's stupendous achievement of getting it all right in its very first attempt at placing a spacecraft in the orbit of Mars. An achievement unmatched by any another country in the world.

The book traces the Mars Orbiter Mission (MOM) right since its inception until its final glorious success. The actual development and implementation of the MOM happened in a record time of 15 months beginning with the official financial approval of the government in July 2012. In just about 18 months – on 5 November 2013 – the MOM had already

been shot off towards its destination thousands of kilometres away. The book talks of the race against the clock to get the satellite ready, working out the detailed mission sequence, getting the technology right (no country has got the Mars mission right on its first attempt) and tackling the innumerable variables before the MOM could be safely ensconced in the Mars orbit.

The Mars mission has stamped a seal of authority on the ISRO's commanding position as a leading space agency in the world, making India proud. Of course, ISRO did have its dark moments. In 1994, its image was severely tarnished when its scientists were accused of spying on behalf of foreign countries. The Devas-Antrix deal hit the country in 2010. Once again in 2010, the country's efforts to make the cryogenic engine indigenously were severely affected due to the GSLV failure. But from then on ISRO has hopped from one success to another launching several satellites with remarkable finesse. The crowning achievement came with the tremendously successful Mars mission.

Pallava and Subhadra have brought out remarkably the motivation, the pride and the creativity of the scientists and engineers at ISRO even under trying circumstances that has helped the

INDIAN SPACE FACTS



GET THE FACTS: INDIA IN SPACE by Biman Basu, published by Scholastic India Pvt. Ltd., A-27, Ground Floor, Bharti Sigma Centre, Infocity-I, Sector-34, Gurgaon-122001; 2015; Pages 176; Price Rs 125/-; ISBN: 978-93-5103-709-5

Get the Facts: India in Space gives you all the information you wanted to know about one of independent India's most successful high-profile programmes whose successes have made every Indian proud.

premier agency notch up successes with marked precision. Pallava Bagla has been reporting first-hand on the country's space endeavours for the NDTV for quite some time now. Not surprisingly, therefore, the book pulsates with the excitement and the dynamism that pervades the hallowed precincts of ISRO.

The book dwells at great length on what makes ISRO the government sector's "dark horse that upsets all definitions of a typical government organisation". It talks of how ordinary engineering graduates join ISRO as a first job and never leave till they retire. What's more, they learn never to let their motivation, interest and creativity sag. Towards the end, Pallava and Subhadra profile the main characters in the Mars mission saga.

The book also takes a look at the exciting future that the ISRO has planned for itself with much more critical challenges in the offing. ISRO scientists and engineers are focusing on Chandrayaan-2 that hopes to land a rover

on the Moon's surface; Aditya is slated to fly to the Sun soon; there are also plans of sending Indians into space.

The story of India's space organisation, which has made its mark as one of the most premier space agencies in the world, has been very well laid out in the book. What makes the book more appealing is that it is illustrated with colourful photographs shot by Pallava Bagla, who is also a professional photographer, and many photographs sourced from agencies.

Replete with interesting anecdotes the book will make for fascinating reading for anyone interested in an insight into one of the most professional organisations in the country. It will also be an eye-opener for the younger generation who would find the facts and stories inspiring.

Hasan Jawaid Khan

- An old Catholic church called St. Mary Magdalene's church and its parsonage, on the seaside at Thumba, became the first offices of the Indian space programme.
- Sriharikota Island in the state of Andhra Pradesh on the east coast is located very near the equator. Satellites launched from here get an additional boost of about 1,660 kilometres per hour due to the Earth's spin.
- The early INSATs were the world's first multipurpose satellites that could simultaneously provide three services – telecommunications, weather observation and TV relay.
- Chandrayaan-1 operated for 312 days as against the planned mission of two years, but the mission achieved 95 per cent of its planned objectives. Among the many achievements was the discovery of the widespread presence of water molecules in lunar soil.

These and many other interesting facts form the contents of this book that traces the inception of India's space programme right from the 1960s, culminating with the highly successful Mars mission. There are facts relating to the various programmes of the Indian Space Research Organisation (ISRO) and the several allied facilities of ISRO that have played an important part in operationalising India's space programme. It also talks about the various satellites and the rockets that have carried these satellites to their intended destinations.

Get the Facts: India in Space gives you all the information you wanted to know about one of independent India's most successful high-profile programmes whose successes have made every Indian proud.

At the end there is a table giving a list of Indian satellites, another table giving the significant milestones of the Indian space programme and finally a list of abbreviations.

Hasan Jawaid Khan

Science Communicators' Meet at the Indian Science Congress 2015

PARUL R. SHETH

THE 8th Vigyan Sancharak Sammelan (Science Communicators' Meet) was held as a part of the 102nd Indian Science Congress, Mumbai, on 4th and 5th January 2015 at the D.N. Marshall Hall, J.N. Library; University of Mumbai, Kalina Campus. The Meet was supported by grant from the National Council for Science & Technology Communication (NCSTC), Department of Science and Technology (DST), Government of India. Eminent science communicators gathered at the event to discuss dissemination of science to the people.

Padma Bhushan Dr. R.A. Mashelkar was the chief guest at the inaugural function. Dr. S.B. Nimse, Vice Chancellor, Lucknow University, General President, Indian Science Congress Association (ISCA), Dr. Rajan Welukar, Vice Chancellor of University of Mumbai, Dr. B.P. Singh, Head, NCSTC, DST, New Delhi, Dr. Naresh Chandra, Pro Vice Chancellor of University of Mumbai and Local Secretary, ISCA, Prof. Arun

Kumar, General Secretary, ISCA and Dr. Amit Krishna De, Executive Secretary, ISCA were present on the occasion. Dr. Anuradha Ghosh-Majumdar, Faculty in Pharmacology, Bombay College of Pharmacy, Senate member—University of Mumbai, convened the symposium.

The two-day symposium included 15 oral presentations and 11 poster presentations and invited talks on advances in science and technology, science communication and science educational tools at the school and university level. The focus was on topics such as policies on science communication, use of online tools, reporting of Mars Orbiter Mission (MOM), science communication in effective conservation and improving public perception of peaceful use of atomic energy, and cheaper diagnostic tools leading to constructive deliberations to improve the effectiveness and outreach programmes for various forms of science communication.

Dr. Naresh Chandra welcomed the dignitaries at the inaugural session. Dr. Mashelkar released the abstract book of the 8th Science Communicators' Meet:

a compilation of abstracts of papers presented by the participating scientists and science communicators. Prof. Arun Kumar acclaimed the efforts of Mumbai University in organizing the Indian Science Congress at the venue and appreciated the relevant theme of the year. Dr. Singh averred that science communication as a tool to enrich the society at large can deeply touch the lives of people.

Such deliberations are crucial to propagate science at the grass root level, said Dr. Majumdar. She stressed the importance of disseminating science in the layman's language keeping pace with the changing paradigm and said that the onus is on the scientific community to instill the spirit of effective communication.

Dr. Mashelkar acclaimed the efforts of the organizers to bring together Nobel laureates for this special meet. Talking about innovation playing a major role in scientific research, he recollected the speech of Prime Minister of India, Shri Narendra Modi that stressed upon using the available resources to advance sciences and that social innovation is a must and the power of communication is great but is yet untapped for Science and Technology and for which there is a need to unify government policies and research. Dr. Mashelkar emphasized the need to eradicate misconceptions regarding nuclear energy. Looking forward to a bright future he anticipated that young innovators would continue to be in the field of science, considering scientists as their role models.

Dr. Welukar assured that the proceedings of the symposium would be uploaded on YouTube. On behalf of the Indian Science Congress and University of Mumbai, Dr. Amit Krishna De proposed the vote of thanks for the inaugural session.

In the invited talk series, Dr. Manoj Patariya, Additional Director General, Doordarshan, Prasar Bharti,





Dr. Manoj Patariya, Additional Director General, Doordarshan, Prasar Bharti, New Delhi, talked about what public and policymakers think about science communicators.

milestone mars mission conducted by the Indian Space Research Organization (ISRO). He revealed the challenges that journalists underwent in reporting the record-breaking accomplishment of MOM to people in a simple and interesting way.

Mr. Laxman gave a vivid description of events that occurred during the launch of the Mars mission. He stressed that ISRO's policy of openness and transparency made it easy for the media-persons to record and cover every aspect of the project. In September 2014, ISRO scientists explained the journalists about the complex maneuver involving the Mars Orbit Insertion and on 24 September 2014, the media witnessed the critical high-security mission operations in Bangalore in the presence of Prime Minister of India Shri Narendra Modi.

He revealed the importance of the number 1099.98 m/s, which flashed on the digital screen at the launch station; the number indicated the spacecraft's changing velocity. He said that the success of the mission was significant mainly because India is the first country to have accomplished the Mars mission independently, India is the first country to have reached Mars using up a mere 71 million dollars as compared to NASA's Maven mission that spent 671 million dollars and India is the first country to successfully complete the mission in a short span of 15 months.

Mr. Laxman informed that the *TIME* magazine published a picture of Mars taken by the Mars colour camera on board the MOM. The US Planetary Society praised the quality of the images saying that they were superior to those taken by Hubble Space Telescope.

The last set of invited lectures was chaired by Mr. Gauhar Raza and Mr. Suhas Naik-Satam and coordinated by Prof. Kumar. Dr. S.K. Malhotra, Head, Public Awareness Division, Department of Atomic Energy, Mumbai presented his talk on 'Role of communication in managing public perception about atomic energy'.

Today, atomic energy is used globally and it touches almost every aspect of human life including meeting the

New Delhi, talked about what public and policymakers think about science communicators. The session was chaired by Dr. De and Mr. Biman Basu, former editor, Science Reporter, and was coordinated by Mrs. Ujjwala Tirkey, Scientist, DST.

Dr. Patariya felt that a host of R&D work done in laboratories, research institutions and universities does not reach the common man. At the same time, the technical problems faced by the common man do not reach the scientists, inventors or policymakers. This is the reason why a two-way science communication model is desirable. In the age of globalization, social networking, and cut-throat competition, adulterated, biased and politicized science information spread by several interest groups needs to be distilled in a way that the common man and the policymakers understand "true science". Such a complex task calls for a fine blend of skill, aptitude, knowledge and wisdom in a science communicator.

Amongst the invited speakers, Mr. Charusadan Kasturi, Assistant Editor, The Telegraph, New Delhi talked about the untapped possibilities for Indian science communication using online tools. In order to delve deep into the language and context of scientific work, he stressed that scientists should communicate with their peers about their latest research. One of the biggest challenges that science journalists and communicators face is reaching out to people who are unfamiliar with the subject. He mentioned about the opportunities that online journalism could offer to reach out to people.

Today, longer science write-ups and narratives are possible without having to worry about the space crunch as in mainstream publications. Science stories can now be accompanied by dynamic, interactive graphics that can help the users navigate online. Most international science and mainstream publications have adopted these strategies, said Mr. Kasturi and India should use these to communicate science to the new generation.

Mr. Hans Desale, Associate Scientist II, Receptors Inc., USA talked on 'Mass communication and the effects on scientific innovation'. He mentioned that the information age has brought forward technology previously unheard of, which has allowed instantaneous communication between the scientists. Unfortunately, technology today has enabled discovery to reach mass audiences, catalyzing misinterpretation or falsification of scientific breakthroughs leading to harmful repercussions.

Mr. Desale stressed upon the dangers and perils of data being misrepresented, conflicts between science and religious views and self-interests as motivation of non-experts. According to him, scientists must use the tools that the Internet age has given them to regain the trust in the population, because anything hindering scientific innovation also hinders human development.

Under the title 'The Indian Mars Orbiter Mission (MOM) – a journalists experience', Mr. Srinivas Laxman, space journalist, formerly with the *Times of India*, Mumbai, gave an insight into the



challenges of the ever-increasing demand for energy, food and water, assisting in industrial growth, healthcare and environmental issues. Dr. Malhotra said that in spite of the immense contribution of atomic energy to the overall societal growth, certain sections of the society are either unaware or are indifferent to these contributions. Some of them in fact oppose nuclear energy and paint it as a dangerous technology. It is therefore important to address perceptions that are not based on scientific facts about nuclear energy through communication with the stakeholders in a language that they can understand and appreciate.

Dr. Malhotra elaborated about the major public perceptions regarding atomic energy and corresponding realities and emphasized the importance of communication for a wide public acceptance of atomic energy. For this, he stated that the Department of Atomic Energy has taken several initiatives as future action plan for a successful communication strategy.

The next invited lecture was by Dr. Asad Rahmani, Director, Bombay Natural History Society, Mumbai on the 'Importance of Science Communication for Conservation: Few Case studies'. Dr. Rahmani averred that support of the general public, media and decision makers is required for conservation, particularly of species that live in large landscape and/or in public places. Communication based on good scientific results generates public interest and conservation actions, he said. He cited examples of the catastrophic decline of Gyps species of vultures and conservation measures that have been repeatedly highlighted by the media. Similarly, large-scale killing of Amur Falcons in Nagaland till 2012 and the public outcry when media took it over resulted in quick conservation action

as a result of which Amur Falcon killing in some areas in Nagaland was totally stopped. The protection of Sarus crane that lives in a large landscape dotted with small wetlands can be achieved only with good science (to know their movement) and public support, he added.

Dr. Rohit Srivastava, Associate Professor, Department of Biosciences and Bioengineering, Indian Institute of Technology (IIT) Bombay, Powai, Mumbai talked about 'Affordable point-of-care diagnostics'. There is an increasing demand for accurate, efficient and cost-effective treatment methods and devices in critical care units. Dr. Srivastava focused on the main goal behind the research in Nanobios Lab at IIT Bombay that relates to the development of biosensor assays and their integration into affordable point-of-care diagnostic devices.

Giving away the details, he said that Nanobios Lab in collaboration with Biosense Technologies Pvt. Ltd. has already commercialized uChek (<http://uchek.in>) - a low-cost smartphone-based urine dipstick reader. uChek can interpret up to ten components in urine including glucose, bilirubin, ketones, proteins, uro-bilinogen, pH, SG, occult blood, leukocytes and nitrites. He further added that the accuracy of uChek was found to be comparable to commercially available semi-automated urinalysis instruments in laboratories with 100 per cent readings within +/-1color block. uChek was launched on 28th April 2013 in India and in the United States and there are around 1000 uChek systems operational across the world.

Dr. Srivastava revealed that the Nanobios Lab in collaboration with Biosense Technologies Pvt. Ltd have also manufactured and commercialized "SuChek" - an indigenous, accurate, low-

cost glucometer supported by the Indian Council of Medical Research (ICMR). SuChek reagent strips are as accurate as conventional glucometers, at a fraction of the price. Along with the glucometer, the companion SuChek mobile application helps save, trend and analyze blood-glucose levels at an individual level or track response to treatment at a community level.

Dr. Srivastava believes that these are small steps towards "Make in India and Made in India" and a lot more needs to be done to educate everyone about the importance of making healthcare affordable in India.

Dr. Randy Schekman, Nobel Laureate Physiology or Medicine in 2013, who graced the Valedictory Function talked about dissemination of scientific research through publications in journals. He expressed his viewpoint that mere publication of a research paper in a high-impact journal does not indicate the quality of research. He opined that online journals are better than printed ones because the publication time is reduced and these are easily accessible to the readers.

Chief Guest Shri Vinod Tawde, Honorable Minister of Higher and Technical Education, Maharashtra stated that success of science and technology is incomplete without it reaching the common man not remaining limited to the scientific community. According to him it is imperative to propagate and implement science for the progress of mankind.

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Indo-French Seminar on Women in Science

JAIMINI SARKAR

AN Indo-French seminar on 'Women in Science' was organized from 3rd to 5th February 2015 at the Indian Institute of Science (IISc), Bangalore. The seminar showcased the excellent research work done by women scientists in the framework of projects funded by the Indo-French Center for Promotion of Advanced Research (CEFIPRA). It also sought to encourage an Indo-French dialogue to arrive at best practices for increasing women's participation in science and making it more efficient and effective by learning from each other's experiences.

The seminar attended by 250 participants was arranged with the collaboration of four institutions namely Indo-French Center for Promotion of Advanced Research (CEFIPRA-www.cefipra.org), Service for Science and Technology at the French Embassy in India (SST-www.frenchscienceindia.org), Indian Academy of Sciences (IASc-www.ias.ac.in) and Indian Institute of Science (IISc-www.iisc.ernet.in).

The pictures of two women of high accomplishments – India's first woman to qualify as a doctor from USA, Anandi Gopal Joshi, and France's Marie Curie, the first woman to win a Nobel Prize – were used as a symbol of the Indo-French science collaboration. Madam Marie Curie's name is synonymous with the highest excellence in science. What is perhaps not well known even in India is the equally inspiring story of Anandibai who became a medical doctor in 1886. Married to a man about 20 years elder to her at the age of 9, Anandi was, however, home-schooled by her husband and sent to USA to become a medical doctor. However, she sadly succumbed to Tuberculosis in 1887.

Dr. Debapriya Dutta, Director, CEFIPRA gave a brief talk on how CEFIPRA is serving as a model for bilateral cooperation in Science and Technology. Established in 1987, the Centre receives financial support from the Department of Science & Technology, Government of India and the Ministry of Foreign Affairs, Government of France. He also presented opportunities and tools to promote, support and encourage Indo-French Scientific cooperation.

Dr. Jenifer Clark, Attaché for science and technology at the French Embassy in India, also gave a brief presentation on opportunities for scientists through such programmes. When asked about the strengths which Indian and French women can exchange from each other, she replied, "At the scientific level, scientists from India and from France, whether women or men, benefit highly from working together on Indo-French research projects. Indeed, we see that the impact factor of Indo-French co-publications is higher than that of publications from just France or just India."

On the issue of shifting careers from laboratory research to science-related jobs, she said, "For young researchers who want to shift from bench-work towards other science-related jobs, it is necessary to develop some specific skills and attributes



Jenifer Clark, Attaché for Science and Technology, French Embassy in India

Dr. Debpriya Dutta, Director, Indo-French Center for the Promotion of Advanced Research

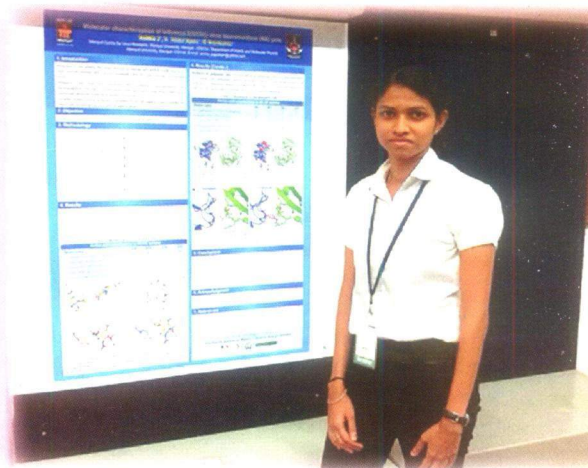


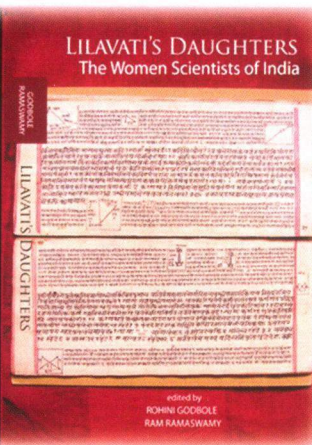
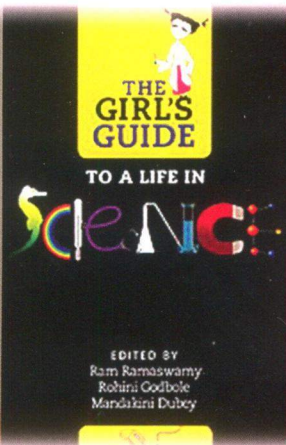
like networking, public speaking, team work, flexibility, adaptability, efficient time-management and good ability for multitasking."

Dr. Jenifer Clark said that to gain these skills training sessions, opportunities to present research work (especially to non-specialists), doing internships in science policy and management organizations (funding agencies, ministry departments, research charities, etc.), using social media to discuss science, writing general science articles and learning about business development is very important. "I think it's important to start preparing for a career outside of research before making the switch – indeed non-academic jobs are competitive too, so it's good to make sure that it is the right position for each person," she said.

The panel discussion on the second day of the seminar showed that the challenges faced by women pursuing a scientific career in France and in India are actually very similar

Anitha Jagadesh of the Manipal Centre for Virus Research presented a poster on her work on Influenza-A viruses

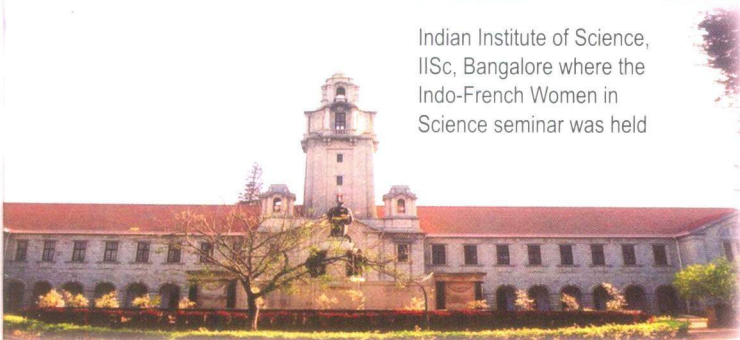




Prof. Rohini Godbole of the Center for High Energy Physics at IISc and the two books she has edited

Prof. Rohini said, "The numbers are increasing but ever so slowly. Among the National Science Talent Scholarship holders I recall in our group of 40-80 odd we were may be three girls. I think now the percentages are certainly higher...."

Indian Institute of Science, IISc, Bangalore where the Indo-French Women in Science seminar was held



in both countries. Several measures are been taken in France to improve the situation for women scientists, regarding career advancement (reducing the male advantage for promotion), changing mind sets, representation of women in large research programmes and conferences, etc.

According to the panelists, in India too there have been discussions and some programmes have been set up to help women restart a career after a break. However, not many policy changes have happened yet. The importance of getting precise statistics on the Indian situation for women scientists was agreed by all the panelists. This is something on which the French initiative 'The Mission for the Place of Women at CNRS' could help since they have been collecting and publishing precise data in France. In addition, some of the measures already put in place in France (such as fight against sexual harassment in research, gender equality trainings for decision-makers and research committees, etc.) could be shared with Indian colleagues so that they could be adapted to the Indian context.

Prof. Rohini Godbole from the Center for High Energy Physics, IISc; Chair, Panel for Women in Science, IASc as well as member of the Scientific Council of CEFIPRA, gave the keynote address. When asked to comment on the difference in the situation of women in science today as compared to her time, Prof. Rohini said, "The numbers are increasing but ever so slowly. Among the National Science Talent Scholarship holders I recall in our group of 40-80 odd we were may be three girls. I think now the percentages are certainly higher. When I joined the TIFR theory group as a visiting fellow, i.e. a post-doctoral fellow, I was perhaps the first one in the theory group at TIFR and there was only one woman Professor among 50 odd Professors in TIFR. Compared to that, things have changed somewhat. In theoretical High Energy Physics I can count about 10 active women physicists."

Many Indian women give up their scientific career due to some or the other reason. It is a loss of resources invested, especially if education they have taken is public funded. When asked about this Prof. Rohini said, "I find this wasteful on two grounds. First, for the reason you mention that the resources and efforts which have been invested in the training do not bring return. Some people at times might quote that as a reason for not encouraging women to be involved in higher studies and research training. But to me, even more importantly, it reduces the diversity in the input that is given to science in general. I do not mean to indicate that there is difference between science as done by men and women but science being very individualistic every human being contributes in his or her own unique way."

Prof. Rohini said that the best period where intervention can make a difference is early career period where one has to settle in a career and which is also the time when one must start a family. "According to me the best intervention is not necessarily to afford schemes to come back to the mainstream but rather introduce Institutional, Social and Policy structures which would allow a smooth negotiation of this early period," said Prof. Rohini.

A large number of young women scientists from all over India were present in the seminar and presented their scientific work at the poster presentation session. Anitha Jagadesh, a 2nd year PhD scholar at Manipal Centre for Virus Research, Manipal University presented her research on the Neuraminidase (NA) gene of Influenza A viruses. About the conference she said, "Conferences like these not only provide an opportunity for budding women researchers like me to present our research work, but also helps to learn from experienced and eminent scientists."

The exhibition-cum-sale counter had books like the autobiography of C.V. Raman, *A Girls Guide to a Life in Science* – an inspirational book for young girls who are aspiring for science as a career, and *Lilavati's Daughters: Women Scientists of India* – containing biographical sketches of about 100 women scientists of India.

When asked for a message for young girls who want to pursue a career in science, Prof. Rohini Godbole, who has co-edited both the above books, replied, "The world is yours. Go, do what you want to do! Nothing else matters except your passion for Science!"

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NATIONAL SYMPOSIUM ON DRYLAND BIRDS

"Strategy for Conservation and Management"

9th- 10th January 2015



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National Symposium on Dryland Birds

MEETA KUMARI

A "National Symposium on Dryland Birds: Strategy for Conservation and Management" was organized by the Gujarat Institute of Desert Ecology (GUIDE) from 9 to 10 January 2015, at K.S.K.V Kachchh University, Bhuj, Kachchh in Gujarat. GUIDE, established in May 1995, is a premier research organization based in Bhuj carrying out various research activities in the field of Ecology and Environment.

The first day of the Symposium was devoted to technical sessions while an excursion was planned on the second day to an area called 'Chhari Dhandh' situated approximately 80 km northwest of Bhuj. Chhari Dhandh is famous for a variety of birds, many of which are migratory in nature, travelling long distances to reach there.

There were four technical sessions, each embracing a distinct theme. The first technical session was on "Dryland Scenario – Status and Distribution" which had two invited lectures and 9 oral presentations. The second technical session had the theme "Ecosystem Services of Birds" with two invited lectures and 9 oral presentations. The third technical session had two invited lectures and eight oral presentations on the topic "Issues and Threats to Birds". The last technical session had deliberations on "Conservation and Management of Birds". It contained two invited lectures and eight oral presentations. Most presentations were from Gujarat, however, there were also presentations from Tamil Nadu, Maharashtra, Madhya Pradesh, Uttarakhand, Uttar Pradesh, Rajasthan, and West Bengal. The absence of people from north-eastern states is a matter of concern and the organizers should try to reach these areas in the future events.

The list of dignitaries gracing the occasion include: Dr. J.A. Khan, Principal Chief Conservator of Forests & Chairman, Gujarat Biodiversity Board; Shri U.D. Singh, Chief Conservator of Forests, Kachchh Circle, Gujarat State Forest Department; Dr. A.P. Singh, Member Secretary, Gujarat Biodiversity Board; Dr. P.A. Azeez, Director, Salim Ali Centre for Ornithology and Natural History (SACON); Shri R.V. Asari, Director, Gujarat Institute of Desert Ecology (GUIDE) and Dr. G.A. Thivakaran, Chief Principal Scientist, GUIDE.

Various avi-faunal issues were deliberated throughout the day during the course of the invited lectures and oral presentations.

Whereas Deomurari and Matieda provided a glimpse of the new generation of tools and techniques available for avian conservation, the lecture by Prof. K.K. Sharma guided the participants towards employing bioacoustics tools for identification and monitoring of birds. The presentation by Dr. J.A. Khan and Dr. A.P. Singh highlighted initiatives taken by the

*Ilyas and Parveen from the Aligarh Muslim University (AMU) gave an account of the avian composition in and around the Pench Tiger Reserve, whereas David provided information about the dryland birds of northern Tamil Nadu. Chavda et al. studied populations of house sparrow (*Passer domesticus*) in Rajkot.*



Gujarat state for biodiversity conservation. Mehra et al. provided an overview of avi-faunal diversity of arid and semi-arid regions of Rajasthan.

Ilyas and Parveen from the Aligarh Muslim University (AMU) gave an account of the avian composition in and around the Pench Tiger Reserve, whereas David provided information about the dryland birds of northern Tamil Nadu. Chavda et al. studied populations of house sparrow (*Passer domesticus*) in Rajkot, Gujarat whereas Borad and Parasharya studied the status and distribution of the same bird in Central Gujarat during 2007 to 2012. On the other hand, Rathod et al. studied avian diversity in coastal talukas of Gulf of Kachchh, Gujarat. Joshi et al. presented their findings about vegetation association with distribution of various bird species in Uttarakhand. Dey reported avian diversity on a newly emerged island (Nayachar) at the mouth of the Hooghly River in West Bengal. All these presentations were part of technical session I.

Prof. V.C. Soni and Prof. B.M. Parasharya initiated the second technical session with their talk on "Ecosystem Services of Birds (Role of Birds in Different Ecosystems)" and "Role of Birds in Agro-Ecosystem", respectively. Rajgir et al. provided a checklist of avi-fauna species found in the Narsingharh wildlife sanctuary, situated on the eastern border of Malwa in Rajgarh district of Madhya Pradesh. Prusty et al. studied Cattle Egret in selected wetlands of Keoladeo National Park, in Bharatpur, Rajasthan. They called for further investigations regarding the impact of toxic agrochemicals in breeding biology of Cattle Egrets. Rawat et al. inventoried the avian diversity in orchards of Sardar Krushinagar.

The third session began with invited lectures from Sarangi & Prusty who highlighted the story of Mangalajodi, a village situated near Chilika lagoon in Odisha. The villagers of Mangalajodi were earlier involved in poaching activities but today they actively protect the birds around their village. Mangalajodi today hosts more than three lakhs birds in November-December each year. It has been designated as Important Bird Area (IBA) by Birdlife International.

Dave investigated the fate of antibiotics in the environment and how they influence various organisms at different stages of the food chain. The author also presented a paper entitled "Raising Public Awareness for Avian Issues: Attempts from an Amateur Student Researcher", highlighting the birds that I have studied so far and the way forward.

The last session began with an invited talk by Dr P.A. Azeez on unsung functional values of avian services. Narwade and Rahmani presented "Status and conservation of birds of southern tropical thorn forests of Great Indian Bustard (*Ardeotis nigriceps*) Sanctuary area, Deccan plateau of Maharashtra, India". Chauhan et al. presented a case study highlighting people's perception on the conservation of common birds. Among the other presentations were those of Gadhvi et al. presenting the status of the Great Indian Bustard and the future conservation measures in Abdasa taluka of Kachchh district; Prajapati and Mahato who studied the flock size and activities of birds in Thol Sanctuary; and Suthar et al. who presented the conservation measures adopted for the highly vulnerable bird species Stoliczka's bushchat (*Saxicola macrorhyncha*) through Biodiversity Management Committee (BMC) in Kachchh district.

The second day of the symposium was devoted to a visit to Chhari Dhandh. A dhandh is a large, shallow pond used to collect rainwater. Kachchh has 34 such dhandhs. Chhari Dhandh with an area of approximately 10 sq km is the largest among them. Chhari means salt-affected. This place is a paradise for bird-watchers, with around 370 bird species flocking the site in peak season.

Meeta Kumari, D-301, Divyapunj Shalom, Behind Satyamev Hospital, Chandkheda, Ahmedabad-382424, Gujarat; Email:

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DIGBIJOY N. NATH

The Dream Weaver

*"Universe is an illusion
and that we believe and
understand what our brains
interpret and want us to..."*

8am local time, 13 April 2020,
somewhere in the suburbs of Los
Angeles

"What makes you guys shout and yell so early in the morning?" Ken said, as he walked into the living hall with his dishevelled hair, his sleepy eyes searching for new emails in his iPhone. He was woken up by the unusually loud conversation his roommates Jay and Amar were having over the morning coffee.

"Dude, you have no idea how bizarre it's been," commented Amar excitedly.

Jay looked more concerned as he said "Bro, how's it possible that both Amar and I had the same dream last night? We both dreamt about a shadowy figure with uncountable tentacles whose face we couldn't either see or remember, and who told me that the universe is an illusion and that..."

"What... ? You can't be serious!" exclaimed Ken as he cut Jay's statement short. "It is statistically impossible to dream the same dream by three persons in the same night. We had no discussion on any such thing last night – I came home late after you guys went to sleep. How the hell did I see the dream too?"

Ken found that Jay and Amar looked at him without any increased excitement. "What? You folks aren't shocked that I too had the same dream of a shadowy tentacle figure telling me that the universe is an illusion and that we believe and understand what our brains interpret and want us to?"

"You didn't let me finish," Jay continued. "Open your Facebook app; you'll be dead shocked. A few of our friends randomly updated their status commenting about a weird dream without realizing that everyone else had the same dream. As more people started reading it, they all were shocked to see others dreaming the same dream last night, and



now suddenly, Facebook feeds are flooded with descriptions and statements by the shocked crowd, which includes everyone."

Ken's face turned slightly blue with unacceptable disbelief. "It's only 8 am. Not many people wake up this early, and certainly not so many would have posted on Facebook."

"Dude, these are my friends from the east coast and Midwest. They are two to three hours ahead of us in California. It's 11 am in Boston," replied Jay.

"Well then, what about people in China and Japan? They probably woke up 10 hours before us."

"Naah, dude. We checked the Google news, particularly searched for this mysterious dream episode. People from Europe and Asia have not reported anything on this."

Beep beep! Amar's mobile rang. "LA Times news feed says Thousands of people in USA reporting to have dreamt the same dream last night".

10 am local time, 14 April 2020, Bangalore, Centre for Advanced Research in Neuroscience

"So you are telling me that in your dream last night you saw the same shadowy tentacle entity as I had dreamt about, who told you that the universe is an illusion?"

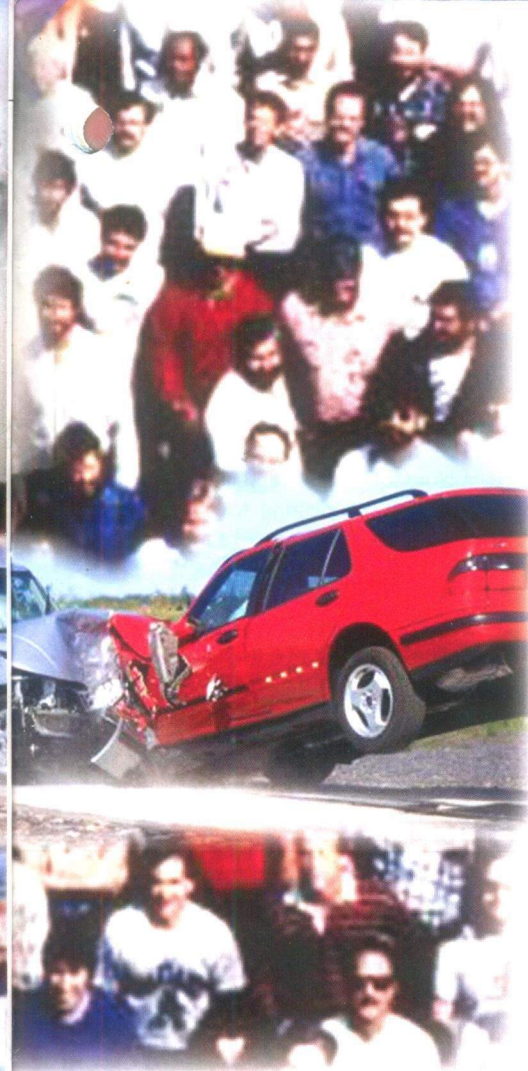
"Yes, Dr. Mishra," replied Anjali. Dr. Vinod Mishra was an internationally acclaimed neuroscientist renowned for his research on human consciousness. Anjali was his office assistant. "It is all over the news, Dr. Mishra. Americans reported about it yesterday. Today, media from China, Japan, Korea and Australia are reporting it along with our Indian people. It seems even reporters and journalists had the same dream."

"Very interesting but highly improbable," remarked Dr. Mishra. "It's probably midnight in some parts of USA now. By 6 pm Indian time today, we shall know if Americans have seen the same dream for the second consecutive night. What did this damn phone had to ring now..."

Dr. Mishra was cut short by the ringtone of his mobile. "Jay beta, is everything alright? You do not usually call me at this time. Are you back from your lab?" Dr. Mishra's eldest son Jay was pursuing PhD in astrophysics at UCLA.

"No dad, things aren't normal. I dozed off unknowingly in the lab and woke up just a few minutes ago. Guess what dad? I had the exact same dream now! I was about to update it in Facebook when I found that at least 50 of my friends had already posted that they too dozed off unknowingly while at work and had this dream. Dad, I fear each person is starting to have this weird dream irrespective of sleeping during night, or any other time. My roommate Ken called me a minute ago, and he told me that he was planning to remain awake the entire night to see if the dream eludes him. He will have a gallon of coffee to keep him awake for the night."

"I agree this is highly strange. Do not panic. We will start investigating into it right away here."



17 April 2020, Everywhere

The inexplicable psychological anomaly engulfing the entire human race, coined Global Hallucination & Odd Sleeping Trend (GHOST), has started taking a gradually intensifying but expectedly serious toll on people's daily affairs, creating chaos and threatening societies. More than 14 flights have crashed in the past two days, killing more than 4500 people all over the world, because the pilots randomly went into a deep and non-wakeable sleep while flying the planes.

Countries played the blame game as usual, with the American media accusing China of releasing some hallucinating yet non-detectable chemical which, they claimed, was inducing sleep among people and making them see the same dream. It took four crashes of Chinese airplanes soon after taking off from Beijing to convince the Americans that everyone was suffering the same fate.

People randomly fell asleep at any time of the day for a brief time-period, dreamt about that mysterious entity in a quick but powerful nap. The GHOST-

induced intensity of drowsiness and the tendency to fall asleep with loss of consciousness was suspected to be more than in the case of the strongest anesthesia. People are unable to keep themselves awake irrespective of what steps they take. Thousands of people have been killed in various road accidents due to drivers of vehicles falling asleep.

The UN and governments round the world are going crazy over GHOST, while the stock market has been crashing exponentially and the economy is suffering badly.

2 am local time, 18 April 2020, Bangalore

"Dad, so you are telling me that based on the people whom you investigated, they seemed to suddenly fall asleep, and that you failed to wake them for those ten minutes of nap even by pricking them with needles, and by splashing buckets of chilled water on them?"

"Right. The sensory organs seem to be disconnected from the brain in a mysterious way. The brain seems to be acting in seclusion and does not give them the feedback during those 20-30 minutes. I spoke to my colleague-cum-friend Dr. Martin in London. His team did similar experiments, and found no traces of any chemical or drug in the ambient which would otherwise lead to everyone falling asleep as opposed to some people randomly falling asleep while others remain awake."

"And you said that each of them claims to have seen the exact same dream during the time they suddenly fall asleep? I had the dream too, while in the flight. Did you have the dream recently?"

"Yes, I had the same dream last night. While dreaming, we do not know that we are dreaming and cannot exercise our consciousness or rationality to control or implement anything. I am helpless in my dream, and do not remember to speak to that shadowy entity."

"Dad, what do you think the reason for GHOST is?"

"I do not know. It has never happened in recorded human history. Medical and neurosciences have no clue. Consciousness is still poorly understood. Every person on this planet dreaming the same dream for consecutive days and nights is the most

incredible thing to have ever happened to humans, I believe."

10 May 2020, everywhere, anytime

It has been nearly one month of the GHOST baffling, puzzling and devastating mankind. Experts in all branches of science or technology are simply helpless against this bizarre phenomenon. The frequency of the same person falling asleep abruptly and dreaming the same dream has increased. Scientists are themselves not able to investigate it properly since many of them collapse in supreme drowsiness in the middle of experiments and doze off for nearly thirty minutes.

Since each and every person on the planet is experiencing the same problem, the entire human race ironically seems to be like a lab rat, caged and controlled by something. Lab resources are dwindling, and due to ubiquitous chaos, almost all labs have started shutting down.

Outside the labs, the ambience looks much worse. People have stopped driving vehicles including bus and cycle, cars and trains. Everyone is scared – "what if I fall asleep while driving?" A conspiracy theory initially pointed to it being the masterwork of the famous multi-product American giant which has been trying to roll out its driverless cars without much success due to various governmental blockades. But it soon turns out that even the American giant didn't have enough driverless cars in stock to cater to even 0.01% of the population in California. It is now too late for them to mass manufacture driverless cars.

Despite the strongest stimulant being consumed in unacceptably high volumes, nobody has been yet able to ward off the GHOST-induced sleep. The brain simply seems to detach itself from everything. Due to near zero vehicle plying, unprecedented food shortage and power outage has gripped even the most advanced societies. Almost all schools, police stations, industries, shops, offices, banks and other social/economic institutes have shut down or are open for very little time.

To prevent large scale death due to starvation, trucks carrying food have more than four drivers in each so as to reduce the probability of it having an accident. The few flights which carry VVIPs have more than five pilots for the same reason.

"His body lay motionless in the equipment. His breathing, heart beat and pulses had stopped. I panicked. A few minutes later, I realized that I just killed my son. His body starting to feel cold. I broke down, collapsing on the floor. Suddenly I felt"

Fighting and killing one another have started for food and water.

Humanity was prepared for an asteroid or meteor impact, for a third world war, for epidemics of highly contagious diseases and perhaps even for an alien invasion as depicted in popular sci-fi movies. But it was not prepared for this psychological 'disease' crippling society without any warning, the inexplicable manipulation of human sub-consciousness. Fear is now rooted deep inside everyone. To survive is the only objective.

4 October 2020, Stockholm, Sweden

"In the rarest of instances and for the first time in its history, the Swedish Academy of Sciences and Norwegian Nobel Committee have decided to award the Nobel Prizes in Biology/Medicine AND in Peace to the same person in the same year. And he is Dr. Vinod Mishra, who saved the human civilization from the brink of extinction by warding off GHOST while simultaneously enabling humans to gain paradigm-shattering insights into consciousness and post-death out of body (OBE) consciousness."

Reporters from hundreds of media houses were flooding thrust their microphones in front of Dr. Mishra in his home. "Please tell us once again the details about everything." Clearing his throat, the scientist in global spotlight, started speaking.

"I had been conducting covert research on out-of-body experience and near-death experiences (OBE/NDE) for many years, without even my closest aides knowing about it. I found, contrary to mainstream neuroscience and to even my own belief, that human consciousness can indeed exist outside of the biological body! To verify my results, I devised a prototype equipment and also synthesized some drugs based on my results, which should be able to trigger separation of consciousness from the biological body but I was not sure if it could enable it to 'return' to the body.

"I still do not know whether consciousness is a form of exotic and hitherto undiscovered force or energy. I have barely scratched the surface; there's infinite knowledge to be acquired and uncountable experiments to be done.

"I was afraid that separating consciousness might kill the subject. This prevented me from trying it on humans. I was about to try it on animals, but GHOST kicked off a chapter of panic and chaos and I couldn't get hold of any animal to try it on. When this chaos reached its peak, I decided to try my device/drugs on myself with my son Jay's help, desperately hoping it would help gain insight into our subconscious which may hopefully enable us to take GHOST head-on. But Jay volunteered and eventually compelled me to try it on him. I was not sure of the fate of his life. It was a really hard decision to make. However, he forced me to go ahead.

"His body lay motionless in the equipment. His breathing, heart beat and pulses had stopped. I panicked. A few minutes later, I realized that I just killed my son. His body starting to feel cold. I broke down, collapsing on the floor. Suddenly I felt as if a high voltage line was fed in to my brain. I screamed and stood up. I could hear or rather feel my son's voice inside my brain! It was an experience unlike anything I had ever had before – to hear and feel someone inside the brain. My son's consciousness was communicating to me.

"The first thing I asked him was where he was and how he was feeling, to which he replied – 'I feel nothing...I feel I have no body...no emotions...I can't see myself or 'see' anything... I am not experiencing the flow of 'time'...past, present and future seem to have been the same point for me and I can see everything everywhere on our planet...for all times in the past and in the future...I perceive a panorama in space and in time... but I seem to retain my memory, hence I'm able to communicate to you in English'.

"I asked him if he could 'see' or read people's minds and find out what was

causing GHOST. He replied 'I do not think I am in the same dimension or universe as you are...I do not know what it is...I see something which stretches like a rubber sheet on everything...I cannot touch anyone or anything... I think I am in some dimension running parallel to but never intersecting yours...Maybe I am dead, or maybe I am dreaming... there is no word in our to explain what I am perceiving right now. It is unreal, beyond imagination...but I do 'see' something around me...it has got millions of bizarre tentacles of bright light...possibly connecting to humans on earth... it is communicating to me...It says it is both single and multiple entity at the same time...It says it is some form of non-physical consciousness that accidentally got slipped and stuck to our universe...'

"I had no idea of what he was trying to convey. His words made no sense; nonetheless I just kept writing them in my notebook. I was more worried about his consciousness returning to his lifeless body. He continued – 'I am about to be merged within the entity. I feel I can take it away from the earth but for that, I need to assimilate myself in it' – And I screamed – 'No son, please do not do that...come back...return to your body soon'. I truly panicked because I was not sure whether he would survive or if he survived whether I could bring him back to his body...but all I could hear was –'Goodbye...I don't think I will come back....I am outside the biological body which called you 'dad' ...I will merge with this being and take it away...somewhere I know not...but GHOST should vanish henceforth...'"

Dr. Mishra's eyes were moist with tears.

"My son is gone. But he ensured that GHOST ended, the world became normal, and we all survived. But everyone must remember that it was my brave son who saved mankind."

Dr. Mishra concluded his interview with the media, and slowly entered his home from the front yard.

Suddenly he stood petrified, his body tingling... he heard a voice inside his brain: "Why did you cremate my body?"

Mr Digbijoy N. Nath is Assistant Professor, Indian Institute of Science, Centre for Nano Science & Engineering (CeNSE), Bangalore, Karnataka-560012; Email: digbijoy@cense.iisc.ernet.in

Prize Puzzle



UNSCRABLE THE WORDS

Unscramble the letters given below to form words, all of which have something to do with the environment.

ONZEO

ACRIGLE

OGLYOEC

RACIHRUEN

ETORSF

LTANP

PRMETEERUTA

DESHERTAW

FLUEETNF

SROENOI



There are three prizes of Rs 500/- each for three correct entries. In case of a large number of correct entries, the prize winners will be selected through a draw of lots. The decision of the Editor, *Science Reporter* will be final.

Send your entries to:

Puzzle Corner

Editor, *Science Reporter*

National Institute of Science Communication & Information Resources (NISCAIR)

Council of Scientific and Industrial Research (CSIR)

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Last date for the
entries to reach us:
05-5-2015

Name :

Address :

..... Pin code:

Age : Email: Sex:

Occupation : Student Housewife Teacher Professional Retired Other

Educational level : Primary Secondary Graduate Postgraduate

- Please fill up the questionnaire at the back
- You can send your answers on a photocopy of this page as well.



GEMS QUIZ

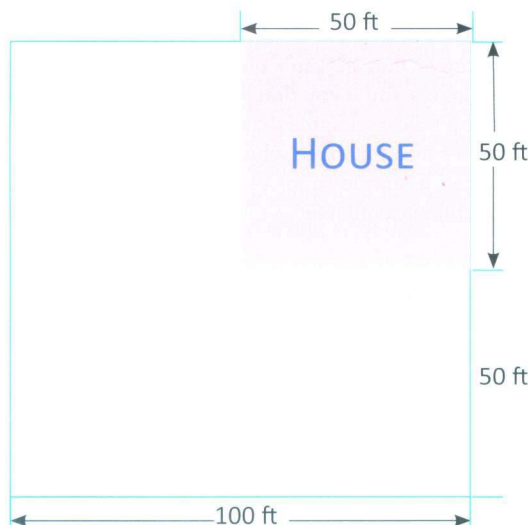
Names of twenty gems are given below. They can be found horizontally, vertically, diagonally or backwards.

A	S	A	P	P	H	I	R	E	E	I	E	O
U	A	E	E	M	E	R	A	L	D	I	N	O
P	C	E	T	I	N	A	Z	N	A	T	O	U
Y	A	O	T	O	R	E	R	O	R	U	T	I
R	O	U	R	I	P	E	P	L	E	R	S	A
I	E	I	O	A	R	A	B	U	P	Q	N	A
T	E	I	O	E	L	D	Z	M	S	U	O	G
E	U	A	T	E	D	I	N	O	A	O	O	A
U	A	A	E	I	Y	A	O	A	J	I	M	R
U	G	A	E	B	I	O	J	U	X	S	A	N
A	E	Q	U	A	R	T	Z	I	O	E	U	E
A	E	R	D	N	O	M	A	I	D	I	L	T
O	U	A	E	N	I	R	A	M	A	U	Q	A

Contributed by Dr. S.K. Gurtu, 80/158, Mansarovar, Jaipur-20

SHARING THE PROPERTY

An old man had 4 sons. He had a garden in front of his house with the dimensions as shown (not to scale). How will he distribute the garden between his 4 sons so that each gets equal part of the same size and shape? The house should not be disturbed. How much square feet does each get?



Contributed by A.S.R. Murthy, Sr. Engg. Assistant, Doordarshan Kendra, Ramanthpur, Hyderabad-500013

Solutions to the puzzles published in the February 2015 issue

Prize Puzzle: THE SHRINKING BELT

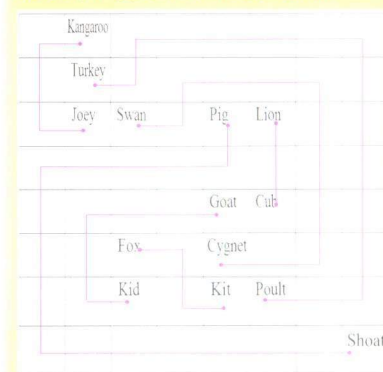
The original length of the belt was 96 cm.

96×9 became 48×3, then 24×1, then 12×(1/3)

NUMBER PUZZLE

2	9	1	6	8	4	5	7	3
5	7	6	1	9	3	8	4	2
8	4	3	5	2	7	9	6	1
1	6	9	8	5	2	7	3	4
3	2	8	4	7	9	6	1	5
7	5	4	3	1	6	2	9	8
4	3	7	2	6	8	1	5	9
6	1	2	9	3	5	4	8	7
9	8	5	7	4	1	3	2	6

MATCH & LATCH PUZZLE



The prizewinners based on the draw from the lot of correct entries are:

- **Hitesh Sodhi,**
13-SC F
Basant Avenue Market,
Amritsar-143001
- **Arka Dutta,**
C/o Krishnendu Dutta
Hatudewan, Pirtala,
PO Bajepuratappur,
Katwa Road,
Burdwan-713101
- **Shreyash Agarwal,**
16/298
Bhola Shankar Street,
Peeli Kothi, Jaiganj, Sasni Gate,
Aligarh-202001

Congratulations

Musings on the Hangman Paradox

ANIRBAN DUTTA

WHAT is a paradox? Wikipedia defines paradox as: "A paradox is a statement that apparently contradicts itself and yet might be true." Generally, a paradox is said to be a condition that causes contradictory or unexpected outcomes.

To understand this better let us take the example of the very famous Liar Paradox. Suppose a man says "Everyone in my family is a liar". Now assuming this statement to be true we can think that, since he belongs to his own family, he must be a liar as well. And so in that case we must conclude his statement was a lie which implies everyone in his family is not a liar i.e. everyone in his family speaks truth. Now we can again reason that since he is a part of his family and that everyone in the family speaks the truth, he must be speaking the truth as well. This brings us back to square one where we assumed his statement was true and applied logical arguments to it.

Thus, we see that we are bound in an endless circular loop, without any hope for final outcome. Even if it is assumed that the initial statement was false we end up in the same hopeless loop. But wait, that is not all.

The Hangman Paradox

This is a famous and yet unresolved paradox. The statement of the paradox is as follows:

"A judge tells a convict that he will be hanged on any one of the weekdays the next week, but the day on which he will be hanged will be a complete surprise

to him and that, he will not know of it until the hangman comes and knocks on his door on that day."

How can this statement be paradoxical? Well, at first sight there's nothing paradoxical but if we dive in a bit deeper we see the paradox. Assuming that the convict is clever, he reasons that if he has not been hanged by Thursday then he must be hanged on Friday (since it is the last weekday) and thus he would be expecting the hangman on Friday and the arrival of the hangman won't be a surprise to him. Since as per the judgment his execution must be a surprise to him, so he can't be hanged on Friday.

Now let's take a step further. If he has not been hanged by Wednesday then, he reasons, that he must be hanged on Thursday, since we have seen executing him on Friday is not an option. So when the executioner comes to him on Thursday, it won't be a surprise to him and thus he can't be executed on Thursday as well.

By now, maybe most of us will start seeing the pattern. As you might guess we can take the above argument a few steps further and prove that he can't be hanged on any weekdays. But if you don't get the argument don't worry, I agree that it is not very intuitive and for those who are not yet convinced a simple proof by mathematical induction is available.

Simple Proof

For those who don't know about mathematical induction, it is basically a way of proving a statement in a simple and intuitive way. What we actually do is show that the statement is true for a particular natural number (generally 1) and then assuming it's true for any arbitrary natural number n , we show that the statement holds for $(n+1)$ as well. Then we say if the statement holds for

$n=1$ (as we showed in the 1st step) then it must hold for $n+1$ i.e. 2. Again if the statement holds for $n=2$ it must hold for $n+1$ i.e. 3 and so on.

Now, suppose there are only two weekdays in a week, namely Thursday and Friday. We have shown above that in this case the convict can't be hanged on either of the days. Now imagine for a moment that somehow the definition of a week has changed and that instead of five weekdays in a week there are now n numbers of weekdays in a week. Let us also pretend that the convict knows, by similar reasoning as before, that he can't be hanged on any of the n weekdays (we don't know it yet but let us just pretend for the moment we know it). Now what happens if we wish to add one more weekday to the week before the first weekday? Does this affect the prisoner?

Now there are $(n+1)$ weekdays in the week, the first weekday being a new addition. We already know that the prisoner can't be executed on any of the last n days of the week (again we are just pretending that we know). So the prisoner can use this line of thought and reason that he must be executed on the first weekday of the week. Thus, he will be expecting the hangman on the first weekday in which case it won't be a surprise to him and so, as per the judgment, he can't be hanged on the first weekday as well. So he can't be hanged at all, even if we add a weekday at the beginning, and the outcome doesn't change even if there are $(n+1)$ number of weekdays.

When $n=2$ i.e. there are two weekdays namely Thursday and Friday, we know that he can't be hanged on any of the two days (as shown before). Adding a weekday, let's say Wednesday, at the beginning such that there are three weekdays, Wednesday, Thursday and Friday in

week makes no difference and the prisoner can't be hanged on any of the weekdays.

Once again we have ended up proving that the statement "The prisoner can't be hanged on any of the weekdays when there are n weekdays in the week" is true when $n=3$. Now, again we can add one more day at the beginning and show that the statement is true for $n=4$ and so on for $n=5, 6, 7...$ etc.

Heart of the Paradox

So far it was simple logic and there was no paradox. But now that the convict knows that he can't be executed on any of the weekdays, he sits back and relaxes. But when the hangman comes and knocks on his door on any one of the weekdays, he is utterly surprised, and so in accordance with the judgment he is executed.

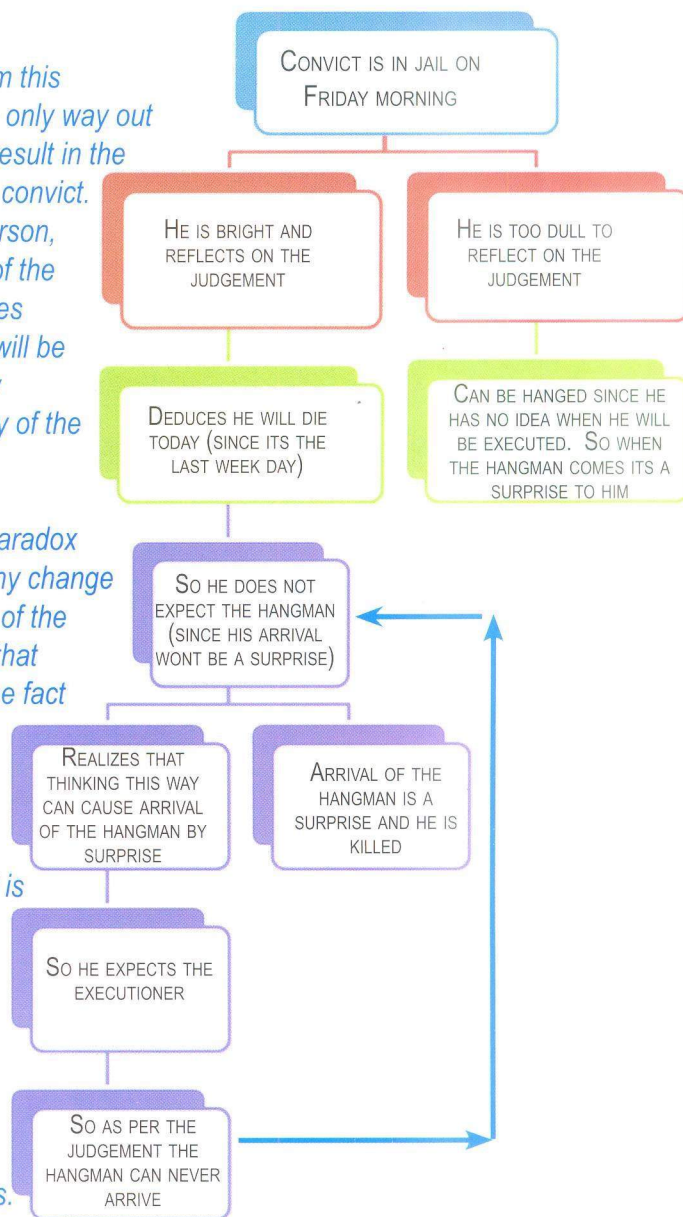
One might also assume that the prisoner expects that he will be hanged on Monday, the first weekday and so theoretically the hangman can't arrive on that day, so the next day, Tuesday he again expects that he will be hanged on that day and again theoretically he can't be hanged on Tuesday and this goes on. Clearly the vague meaning of the word "surprise" causes the paradox to arise and makes formal logical analysis of the problem difficult. There has been considerable amount of debate on this paradox but it still remains unresolved.

Possible Solutions

Assume that the convict hasn't been executed till Thursday. On Friday morning while in jail we draw a diagram of the different possible lines of thoughts of the convict and their outcomes.

Looking closely, we find that the looping part is caused by the fact that the convict's day of execution will be a surprise to himself. But we also see from this diagram that the only way out of the loop will result in the execution of the convict. Now, a dumb person, who can't think of the paradox, assumes that the convict will be executed on any random weekday of the week with equal probability. So, apparently the paradox doesn't cause any change in the outcomes of the event. It seems that irrespective of the fact whether someone decides to think of the paradox or not, the result is always the death of the convict, and that too by surprise as mentioned in the judgment, in both the cases.

We also see from this diagram that the only way out of the loop will result in the execution of the convict. Now, a dumb person, who can't think of the paradox, assumes that the convict will be executed on any random weekday of the week with equal probability. So, apparently the paradox doesn't cause any change in the outcomes of the event. It seems that irrespective of the fact whether someone decides to think of the paradox or not, the result is always the death of the convict, and that too by surprise as mentioned in the judgment, in both the cases.



The above table can be extended to all the weekdays of the week but then the diagram would become much more complex. It seems that the only difference between one who thinks of the paradox and one who doesn't is, the one who thinks of it assumes that he can't be executed on any of the weekdays, while the one who doesn't think of it assumes that the convict can be executed on any of the weekdays. But in the former case if we somehow manage to get out of the self referencing loop then the outcome is the same as in the other case i.e. execution of the convict. So in this sense it's not a paradox at all.

Some claim that the self contradictory and self referencing nature of the judgment causes such a paradox to arise. T.Y Chow claims that the judgment which was pronounced is true only for

the judge and it is not a sufficient ground for the prisoner to assume it true for him as well. And even if the convict knows something is true at the present moment it doesn't necessarily guarantee it to be true at any other time, for example on Monday evening (if he hasn't been already hanged).

However, there are objections to the above solutions that have not been resolved till date and The Hangman Paradox continues to be of significant academic and philosophical interest.

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BTRACK TAIL LIGHT

The BTrack safe light is a thief-tracking tail-light that allows you to track your stolen bike. It is equipped with LED, GPS unit, an accelerometer and special sensors that can be armed using the companion iOS and Android app. It will send an alert to the paired smartphone if it senses the bike being moved. It's also possible to adjust the sensitivity of the alarm in order not to be alerted every time someone brushes by your bike. It also uses a SIM card hidden inside that reports the stolen bike location to an app on the phone at all times.
(www.nbcnews.com)



PLAYBOX

PlayBox is a gaming laptop that combines Playstation 4 and Xbox One into a single unit. The PS4 sits on the left-hand side of the unit, and the Xbox One is on the right side. The whole unit only takes one power cord but only one unit can be powered on at the same time due to potential heating issues. There is a red switch on the back of the PlayBox to go back and forth between both consoles. The laptop has a 1080p 22-inch screen and two Ethernet ports for wired connections to the Internet for each of the consoles.
(www.neowin.net)



ECOADVANCED BATTERIES

Energizer's EcoAdvanced batteries are the first disposable AA and AAA alkaline batteries made from recycled cells. The recycled materials comprise about 4 percent of the weight of the new batteries, but the company is aiming for 40 percent within a decade. It will last longer than other alkaline batteries and cost 20 to 25 percent more than standard batteries. The new batteries include a high performance active ingredient which is derived from old batteries. It has less impact on the planet by requiring less mining of virgin material and reducing the amount of batteries consumers need to power their devices resulting in less waste.
(www.stltoday.com)



CONFERENCECAM CONNECT

ConferenceCam Connect is a portable all-in-one video conference solution with a breakthrough design for small- and medium-sized rooms. It works with any computing device with a USB connection (PC, MAC, or Chromebook), with virtually any videoconferencing software (Cisco Jabber and WebEx, Citrix, Blue Jeans, Google Hangouts, Microsoft Lync and Skype, Zoom etc.). The product features include HD 1080p video, professional audio, and multi-device connectivity. Miracast technology is also included to allow users to mirror their screen from a Windows 8.1 or Android 4.3 device. The broad-based UC compatibility and its plug-and-play connectivity makes the ConferenceCam Connect easy to deploy in every room.
(venturebeat.com)



BLUEWIRE CALL RECORDER

Bluewire is a hands-free Bluetooth 4.0 headset that can record both sides of smartphone conversations. It can store thousands of hours of audio to its internal 16 GB SD card which can be transferred to a phone by a simple tap on the back of a smartphone. It is also able to store recordings from VOIP services like Skype on Bluetooth-equipped computers and tablets. The headset offers built-in flashlight and is easy to charge wirelessly through Qi wireless pad. It comes with a ring to allow users to attach it to your keys, further increasing its 'find me' usefulness. Additionally, the device comes with a burglar alarm mode activated by the companion app. (tech.firstpost.com)



SONICABLE WILL CHARGE THE PHONE FASTER THAN EVER

Sonicable is the world's most advanced charging cable that charges the iPhone or Android phone twice as fast as using a normal cable. When plugged into the USB port of a computer, it both syncs data and charges the device, but when switched into SONIC mode; it directs all of its resources into charging the device, thereby doubling the speed. The cable is made with tangle-free nylon coating and the connectors are aluminium rather than plastic for durability. It is 20 percent longer than a standard USB cable with a dual-sided USB plug. The cable will be available in lightning cable for iPhone and micro USB for Android. (www.gadgetreview.com)



CARVI BRINGS SAFETY FEATURES TO CARS

CarVi is a device that promises advanced safety features of cars like collision detection, lane change assistance, driver skills assessment, etc. It comes in the form of a chunky black disc 100 mm across and 35 mm in height that fits to just below the rear view mirror by way of an adhesive bracket. It also features a 720p camera along with microphone, speaker, a three-axis accelerometer and Wi-Fi unit to allow it to wirelessly connect to any smartphone. At the end of each drive, it gives you a "SKOR" for your driving technique, taking note of areas like hard braking and hard acceleration, as well as helping you figure out where you can improve to make your driving safer. (www.digitaltrends.com)

LUCI EMRG: A SOLAR LANTERN

Luci is an inflatable solar powered rechargeable lantern that uses four LEDs to project flashlight like beams. The batteries of Luci EMRG remain trapped in the waterproof flashlight and can be powered up using a solar cell built into the bottom. It provides up to seven hours of light on a full charge and lasts up to 10 years without having to buy or change a battery. It features four settings namely bright, super bright, flashing and red-and-white SOS flasher and lantern mode for diffused room lighting. It weighs only 2.5 ounces and is especially useful for blackouts, car breakdowns and extreme weather conditions such as floods and earthquakes. Luci EMRG is an all-in-one lantern, flashlight and emergency light. (www.gizmodo.in)



Metamorphosis

E.S.N MURTHY

1. Ontogeny (the development of an individual) is the repetition of Phylogeny (the development of the race) – 'the theory of recapitulation' was formulated by:

- a) Darwin b) Morgan
c) Haeckel d) Aristotle

2. In the metamorphosis of Butterfly the term 'Chrysalis' is given to:

- a) Larva b) Pupa
c) Juvenile d) Nymph

3. 'Wrigglers' larva metamorphoses into:

- a) Mosquito b) Housefly
c) Butterfly d) Dragonfly

4. 'Retgressive metamorphosis' is found in the life history of:

- a) Amphioxus b) Herdmania
c) Balanoglossus d) Estrogen

5. The hormone that regulates metamorphosis in insects is:

- a) Thyroxine b) Prolactin
c) Ecdysone d) Estrogen

6. "Neoteny" means:

- a) Pupa developing into adult
b) Larva becoming active in feeding
c) The process of molting
d) Larva becoming sexually mature

7. 'Axolotl' is the larva of:

- a) Ambystoma b) Newt
c) Proteus d) Hyla

8. 'Axolotl' larva would not metamorphose into the adult for a long time due to the absence of _____ in the water:

- a) Sulphur b) Iodine
c) Enough food d) Chlorides

9. The fish-like tadpole of Frog loses its tail, gills etc. during metamorphosis due to a cellular change called:

- a) Autogamy b) Autolysis
c) Autopsy d) Autotomy

10. The cellular organelles that bring about cell death and change during metamorphism are:

- a) Mitochondria b) Lysosomes
c) Ribosomes d) Centrosomes

11. The Amphibian that leads a permanent larval life is:

- a) Necturus b) Hyla
c) Ichthyophis d) Salamander

12. One of the Ametabolous insects is:

- a) Mosquito b) Housefly
c) Lepisma d) Dragonfly

13. More than two larval stages are found in the development of most of the:

- a) Ascidians b) Amphibians
c) Crustaceans d) Fishes

14. A bilaterally symmetrical larva metamorphoses into a radially symmetrical adult in:

- a) Aurelia b) Starfish
c) Crab d) Octopus

15. In some of the insects quick molting and metamorphosis are inhibited by:

- a) More feeding b) Thyroxine
c) Prolactin d) Ecdysone

16. 'Glochidium' is the larva of:

- a) Pila b) Unio
c) Patella d) Sepia

17. In the life history of Silk moth 'Silk' is secreted by:

- a) Larva b) Pupa
c) Adult d) Egg mass

18. Among the Echinoderms 'Auricularia larva' metamorphoses into:

- a) Starfish b) Brittle Star
c) Sea Urchin d) Sea Cucumber

19. The Urochordate that exhibits 'Neoteny' is:

- a) Salpa b) Oikopleura
c) Doliolum d) Herdmania

20. In the development of an insect the term 'Nymph' is given to:

- a) Young larva b) Immature adult
c) The process of moulting d) The stage between two moults

ANSWERS:

1.c	2.b	3.a	4.b	5.c	6.d	7.a
8.c	9.b	10.b	11.a	12.c	13.c	14.b
15.c	16.b	17.a	18.d	19.b	20.b	

Contributed by E.S.N. Murthy, HRT Residency-103, Siddhartha Nagar, Vijayawada-520 010 (A.P.)

Orchids of India

SOUMIKA DAS

1. "National orchidarium" was established in 1960 at:

- a) Gangtok b) Shillong c) Kolkata d) Delhi

2. "Orphan Orchids" by nature are:

- a) Epiphytic b) Terrestrial
c) Saprophytic d) Halophytic

3. "Vanillin" – is extracted from the pods of:

- a) Dendrobium nobile b) Cymbidium longifolium
c) Vanilla planifolia d) Vanda cristata

4. "Dendrobium densiflorum" is popularly known as:

- a) Spider orchid b) Pineapple orchid
c) Apple orchid d) Lost orchid

5. The flower of 'Comet orchid' looks like:

- a) Star b) Crab c) Moon d) Grass

6. 'Miltonia' is popularly called:

- a) Bamboo orchid b) Pansy orchid
c) Star orchid d) Palm orchid

7. 'Renanthera imschootiana' is popularly known as:

- a) Yellow Vanda b) Red Vanda
c) Bucked orchid d) Moth orchid

8. 'Lady Slipper orchid' has the scientific name

- a) Pholidota imbricata b) Oberonia iridifolia
c) Paphiopedilum villosum d) Dendrobium candidum

9. "Rhynchostylis retusa" is popularly called:

- a) Foxtail orchid b) Spider orchid
c) Butterfly orchid d) Giant orchid

10. The whole dense flower bunch of 'Foxtail orchid' is locally called:

- a) Bhatsu phool b) Kopou phool
c) Ghetu phool d) Shital phool

11. The Botanical name of 'Comet orchid' is:

- a) Angraecum sesquipedale b) Calypso salisb
c) Thunia alba d) Renanthera imschootiana

12. "Brassia verrucosa" is popularly known as:

- a) Spider Orchid b) Star Orchid
c) Tiger Orchid d) Bog Orchid

13. "Arundina graminifolia" is popularly called:

- a) Peacock orchid b) Giant orchid
c) Bamboo orchid d) Bee orchid

14. The largest orchid flower under cultivation is:

- a) Mexican Giant b) Foxtail orchid
c) Butterfly orchid d) Spider orchid

15. "Encyclia tampensis" is commonly known as:

- a) Giant orchid b) Butterfly orchid
c) Tiger orchid d) Crab orchid

16. The national flower of Panama is:

- a) Peacock orchid b) Tiger orchid
c) Dove orchid d) Bee orchid

17. "Peristeria elata" is popularly called:

- a) Bucked orchid b) Moon orchid
c) Dove orchid d) Star orchid

18. "Coryanthes speciosa" is commonly known as:

- a) Airplant orchid b) Bucket orchid
c) Helmet orchid d) Snake mouth orchid

19. "Odontoglossum grande" is popularly known as:

- a) Giant orchid b) Tiger orchid
c) Crow orchid d) Peacock orchid

20. "Cycnoches chlorochilon" is commonly called:

- a) Swan orchid b) Moon orchid
c) Star orchid d) Crab orchid

21. The tiniest orchid flower is:

- a) Bulbophyllum minutissimum
b) Eulophia epidendreae
c) Thunia alba
d) Cymbidium aloifolium

22. "Acampe praemorsa" is popularly known as:

- a) Bee orchid b) Star orchid
c) Button orchid d) Giant orchid

23. Orchid plants, which grow on the tree, are called:

- a) Saprophytic b) Terrestrial
c) Epiphytic d) None of the above

24. Tubers of 'Marsh orchid' are traditionally used for:

- a) Clotting blood b) Healing wounds
c) Restoring vitality d) Nervous debility

25. Pseudobulb is the main characteristic of:

- a) Saprophytic orchid b) Epiphytic orchid
c) Terrestrial orchid d) Epilithic

ANSWERS:

1.b	2.c	3.c	4.b	5.a	6.b	7.b
8.c	9.a	10.b	11.a	12.a	13.c	14.a
15.b	16.c	17.c	18.b	19.b	20.a	21.a
22.c	23.c	24.c	25.b			

Contributed by Shri Soumendra Nath Das, H.No B-1/359, PO-Kalyani, Dist-Nadia, West Bengal-741235, Email: soumendranathdas63@gmail.com



Insect Mimicking Plants

MAYANGLAMBAM OJIT KUMAR SINGH

Q.1. The plant in the picture is dependent on insects for pollination. The spots on this flower mimic the plant's pollinator, a small bee-fly, *Megapalpus nitidus*. Name the English common name of this plant scientifically called *Gorteria diffusa*.



- (A) South African beetle daisy
- (B) Venezuelan beetle daisy
- (C) Indian beetle daisy
- (D) American beetle daisy

Q. 2. Particularly well known for beautiful deceptions some orchids look like bees, flies and wasps. *Ophrys insectifera* is a species of orchid native to Europe and favors sites with alkaline soil. What is the common name of this orchid?



- (A) The Kombirei
- (B) The Fly orchid
- (C) The Chenglei
- (D) The Moth orchid

Q. 3. The ringed area of the *Fumaria officinalis* flower shows mimicking some insects. This herbaceous annual plant has been highly valued since Roman times for its tonic and blood cleansing effect upon the body. The common name associated with *Fumaria officinalis* is



- (A) Violet smoke
- (B) World smoke
- (C) Earth smoke
- (D) Pink smoke

Q. 4. *Ophrys bombyliflora*, is a species of bee orchid pollinated by males of solitary bees of the genus *Eucera*. The flowers mimic the females in appearance and scent. Name the common English name of this orchid.



- (A) The Honey bee orchid
- (B) The digger bee orchid
- (C) The carpenter bee orchid
- (D) The bumblebee orchid

Q. 5. *Lysichiton americanus*, also called western skunk cabbage, yellow skunk cabbage or swamp lantern, found in swamps and wet woods areas of the Pacific Northwest. Its distinctive "skunky" odour attracts its pollinators such as scavenging flies and



- (A) Moths
- (B) Butterflies
- (C) Ants
- (D) Beetles

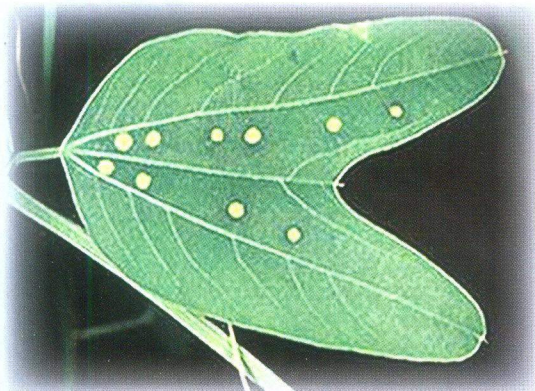
Q. 6. The male orchid dupe wasp is so attracted to this orchid (*Cryptostylis leptochila*) that it ejaculates right onto the flowers' petals. This Australian orchid bears a sufficient resemblance to the female of the male orchid dupe wasp to induce copulation by the male wasp. What common name is given to *Cryptostylis leptochila*?



- (A) The small handle orchid
- (B) The small pink orchid
- (C) The small tongue orchid
- (D) The small spine orchid

FUN QUIZ

Q. 7. This plant isn't a big fan of butterflies laying eggs on its leaves. It develops natural little yellow spots that look like *Heliconius* butterfly eggs, which convince female butterflies to look elsewhere so their offspring don't have to compete with other caterpillars when they hatch.



- (A) The Grape vine
(B) The Passion vine
(C) The Kudzu vine
(D) The Cuscuta vine

Q. 8. *Ophrys speculum*

is a Mediterranean orchid that is pollinated exclusively by a single species of wasp *Dasyscolia ciliata*. Males are lured by the flower, which resembles the female wasp. The blue patch on the floral lip appears to mimic the reflection of the sky on the wasp's wings. What is the common English name of this highly deceitful orchid?



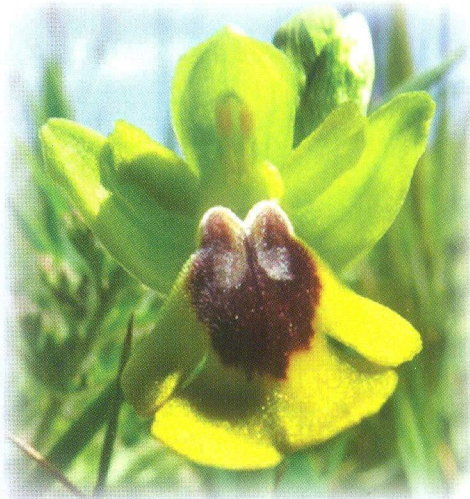
- (A) The mirror orchid
(B) The Blue orchid
(C) The Enigma orchid
(D) The Yellow orchid

Q. 9. The flower of the orchid *Ophrys tenthredinifera* resembles a female insect and also emits a scent similar to female pheromones. This orchid is commonly referred to as:



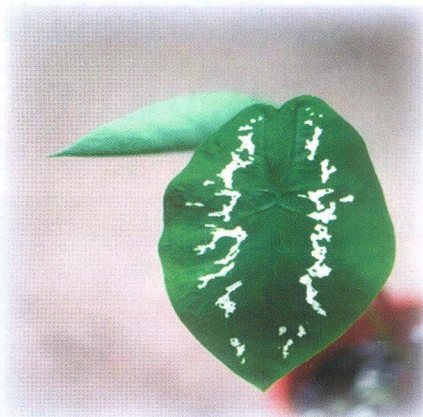
- (A) Sawfly Orchid
(B) Carrion fly Orchid
(C) Tsetse fly orchid
(D) Housefly orchid

Q. 10. *Ophrys lutea* is a species of orchid native to Europe and North Africa. Pollinated by male *Andrena* bees this species is notable among *Ophrys* for the fact that the pollinating bees sit on the labellum facing away from the pollinaria instead of facing towards them, and thus collect the pollinaria with their abdomen. This orchid is also the largest of the *O. lutea* group members and is also known as:



- (A) Violet Bee Orchid
(B) Yellow Bee Orchid
(C) Chocolate Bee Orchid
(D) Hawaiithrak Lei

Q. 11. *Caladium steudneriifolium* actually pretends to be ill, designing its own leaf variegation patterns to resemble signs of disease. Scientists believe that the plant is mimicking the damage that mining moth larvae create. Moths mistake variegated leaves for already-infested ones and avoid laying eggs there. *Caladium* is often known by common names such as Elephant ear, Heart of Jesus, and



- (A) Princes Wings
(B) Heli Wings
(C) Angel Wings
(D) Sorcerer Wings

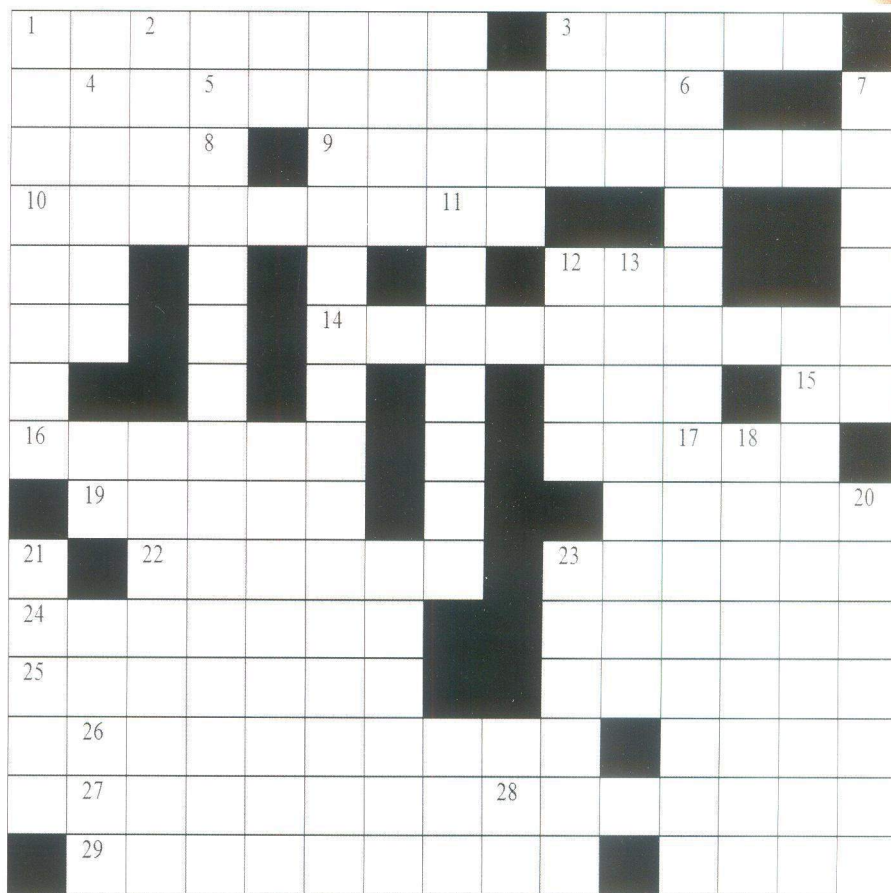
Answers:

- | | | |
|----------|---------|---------|
| 1. (A), | 2. (B), | 3. (C), |
| 4. (D), | 5. (D), | 6. (C), |
| 7. (B), | 8. (A), | 9. (A), |
| 10. (B), | 11. (C) | |

Contributed by Mayanglambam Ojit Kumar Singh, Assistant Professor in Zoology, Ramjas College, Maurice Nagar, Delhi University, Delhi 110007; Email: ojit102005@yahoo.co.in

ACROSS

1. Freshly eroded rock particles that have been carried by streams (8)
3. One of the two types of transport tissue in vascular plants (5)
5. Metallic elements with atomic numbers from 89 to 103 are referred like this (8)
9. Original name for the element niobium (9)
10. A polymer that can be stretched and returned to the original shape (9)
14. Another term for Hybrid vigor (9)
16. A CGS unit for dipole moments (5)
19. A dense icy pack of snow (4)
22. A massive assemblage of stars and planets orbiting around a common center (6)
24. Movement of solvent from higher to lower concentration (7)
25. Bone found in the lower jaw of mammals (7)
26. Moisture content of the air (8)
27. Blood vessel that carries blood to the head region (7)
28. $R - N = N - R'$ refers to this chemical group (3)
29. Uppermost layer of the earth's atmosphere (9)



21. Latin name for iodine (5)
23. Alloy of copper containing tin as its addition (6)

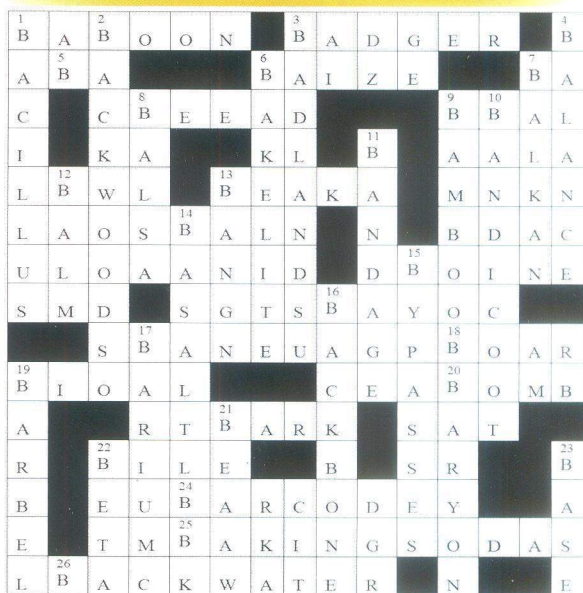
Contributed by Dr K. Venkataraman, A-T-2, Porkudam, Bypass Road, Madurai-16

DOWN

1. A minor planet that revolves between the orbits of Mars and Jupiter (8)
2. Abbreviated form of liquid oxygen (3)
4. Organic compound containing one or more carbon atoms and a halogen atom (5)
6. Activating enzyme (6)
7. Comma-shaped, Gram-Negative bacteria (6)
8. Mixture of an acid and an alcohol (5)
9. Spirally coiled auditory portion of the inner ear (7)
11. Partially enclosed water along the coast where fresh water from rivers meet (7)
12. Circular structure found in eyes that controls the diameter of the pupil (4)
13. Neurotransmitter of catecholamine group (8)
15. Substance that plays a major role in allergic reactions (9)
17. Process of removing waste and excess water from the blood (8)
18. Spiny seeds used a diuretic, commonly known as puncture vine (8)
20. Mass divided by volume (7)

Solution

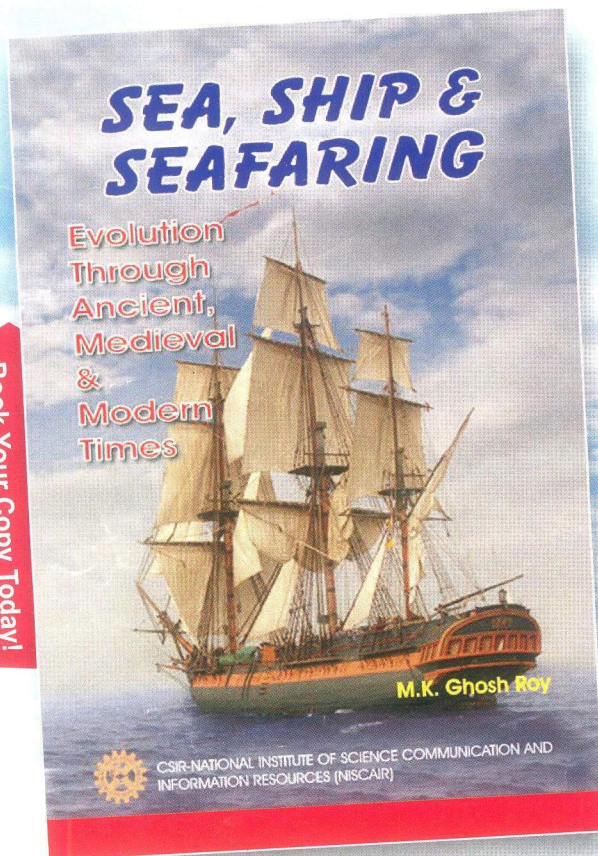
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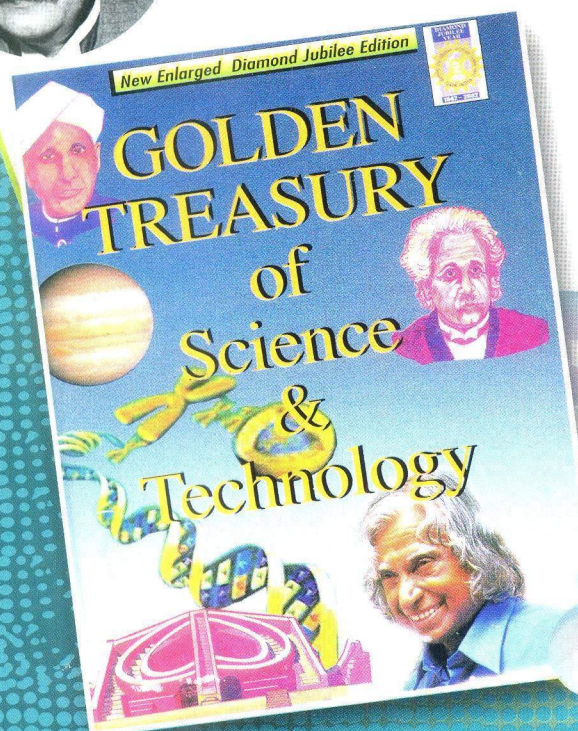
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Postal Reg. No. DL-(C)-14/1064/2015-17
U(C)-79/2015-17 R.No. 7440/1964

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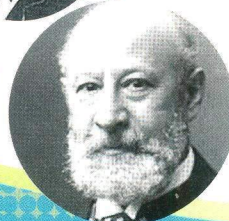
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